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ABSTRACT

Text, illustrations, and exercises are utilized in these five learning modules to instruct nurses, students, and other health care professionals in cardiac anatomy and functions and in fundamental electrocardiographic techniques. The first module, "Cardiac Anatomy and Physiology: A Review" by Gwen Phillips, teaches the learner to draw and label the parts of the heart and its impulse conduction system and describe the functions of these parts. The second module, "Disorders of Cardiac Conduction" by Mary E. Gotelli, examines the causes of and treatments for four types of atrioventricular conduction disorders and explains how to identify these disorders on electrocardiograms. The third module, "Basic Electrocardiography: The Electrical Anatomy of the Heart" by Sharilyn Robinson, explains how the heart is stimulated to beat and how its activities are represented on electrocardiograms. The fourth module, "Events of the Cardiac Cycle" by William G. Buskirk, describes the functions of the heart muscle and valves at each point of the cardiac cycle. The fifth module, "The EKG Connection: Patient, Lead Wires, and Electrodes" by Judy Coleman, describes electrocardiographic lead wires and their connection to electrodes on the four limbs and chest. The modules provide reinforcement exercises and post-tests. (JP)

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HEALTH INSTRUCTION PACKAGES:

Cardiac Anatomy

Modules prepared by:

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William G. Buskirk, Ph. D.

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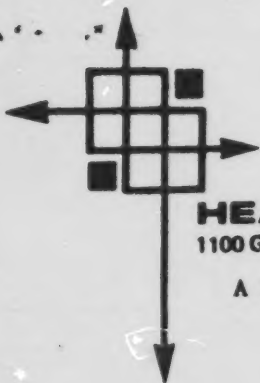
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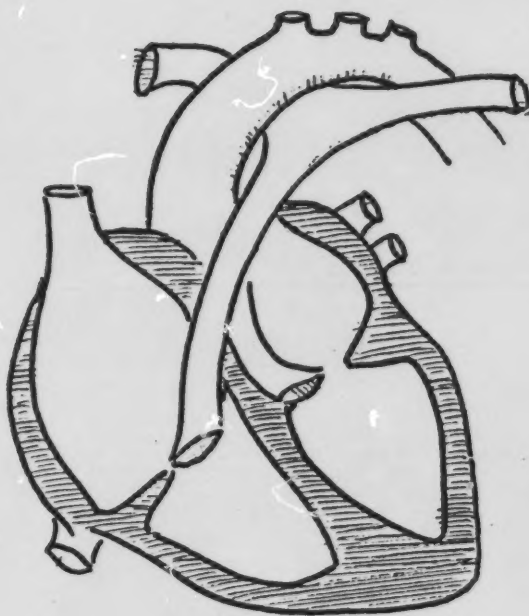
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CARDIAC ANATOMY AND PHYSIOLOGY:

A REVIEW

by

Gwen Phillips



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TITLE: Cardiac Anatomy and Physiology:
A Review

AUTHOR: Gwen Phillips

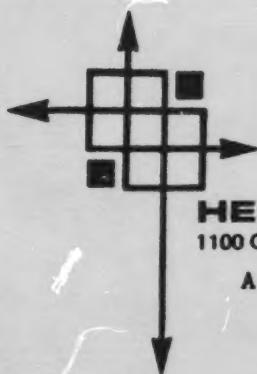
INSTITUTION: Eskaton American River Healthcare Center

INTENDED STUDENTS: R.N.s or L.V.Ns needing review of basic
cardiac anatomy and physiology

Estimated Working Time: 20 minutes

Materials Needed: None

Field Test Copy



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INTRODUCTION

This packet is designed for nursing personnel who want to review basic cardiac anatomy and physiology prior to increasing their skill level in basic cardiac arrhythmia recognition. In order to recognize cardiac arrhythmias it is essential that you know and understand normal anatomy and physiology of the heart.

OVERALL OBJECTIVE

Students who complete the program will be able to draw and label the heart, its conduction system, and explain the function of each part.

When given an outline of the heart and a list of terms, the student will be able to:

- label the four chambers of the heart

- state the purpose of the four heart chambers

- label the heart valves

- state the purpose of the heart valves

- draw the impulse conduction system

- state the purpose of the conduction system

- willingly state that this packet helped develop skills in recognition of normal cardiac anatomy.

Let's begin by having you think of your heart and circulatory system. I would like you to compare these to a water pump and irrigation system.

A water pump sends out water into the irrigation system. The irrigation ditches go to all areas of the field and carry vital substances to the crops.

Now compare this system to your own heart and circulatory system. Your heart works as a pump to send blood out to your body. The blood carries with it many things. Two of the most important for the body are FOOD and OXYGEN. The purpose of the circulatory system is to carry food and oxygen to the body tissues.

Practice Question #1

1) From the list below, check the purpose of the heart

- ☐ works as a pump
- ☐ to help you breathe better
- ☐ to filter out waste products.

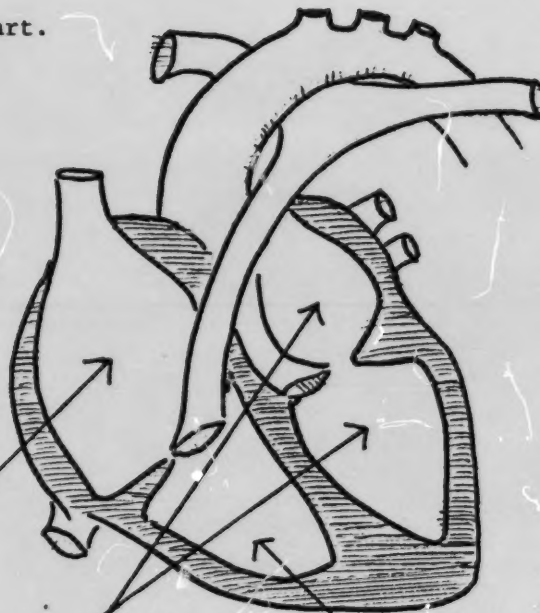
2) The circulatory system goes to every part of our body. As the blood flows through this system it carries things to the body. Select two from below:

- ☐ food
- ☐ heat
- ☐ oxygen
- ☐ hair
- ☐ bones

FEEDBACK:

If you selected the answer that the heart's main function is to work as a pump, that is correct. For the second answer you should have selected food and oxygen.

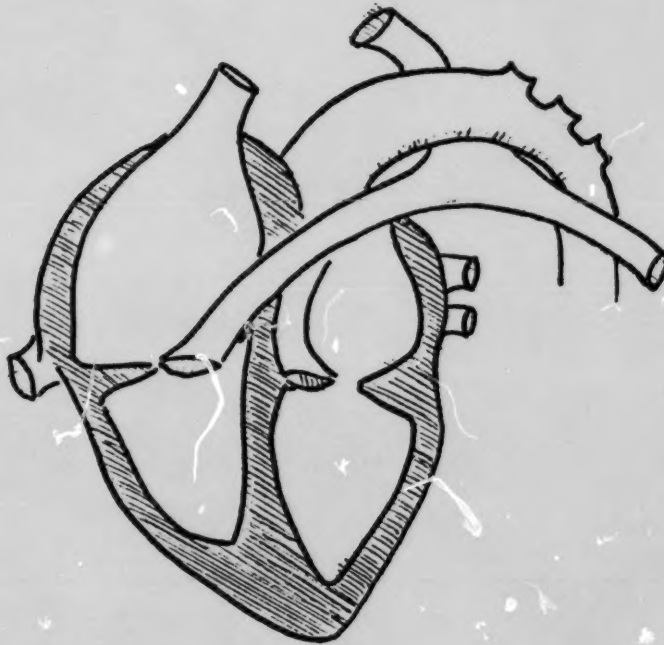
This is a diagram of the heart.



The heart is divided into four chambers. The two on top are the RIGHT ATRIUM and the LEFT ATRIUM. The bottom two are the RIGHT VENTRICLE and the LEFT VENTRICLE.

Practice Question 2

Draw a line from the term on the right to the correct place it identifies on the diagram. When you've finished, check your diagram with that on Page 3.

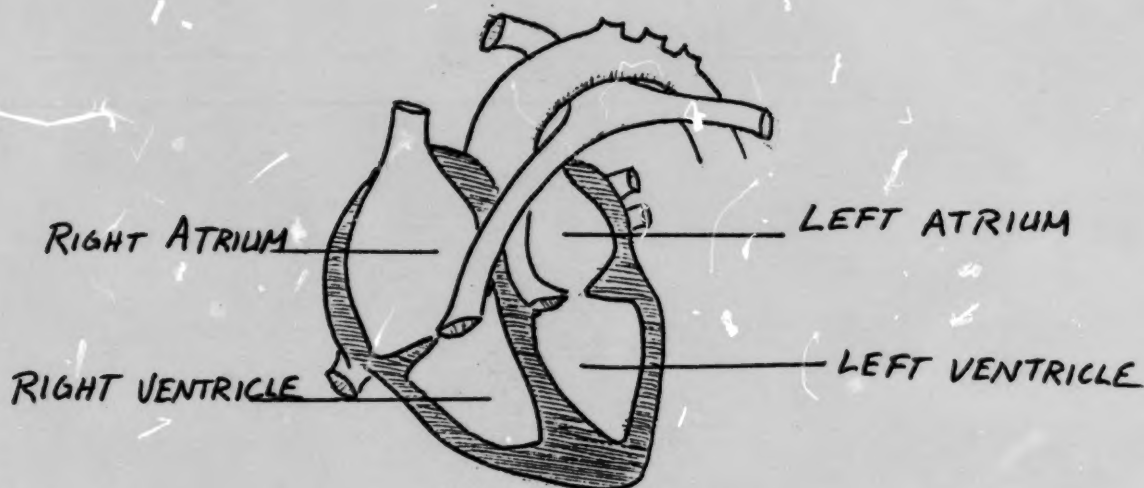


Right atrium
Right ventricle
Left atrium
Left ventricle

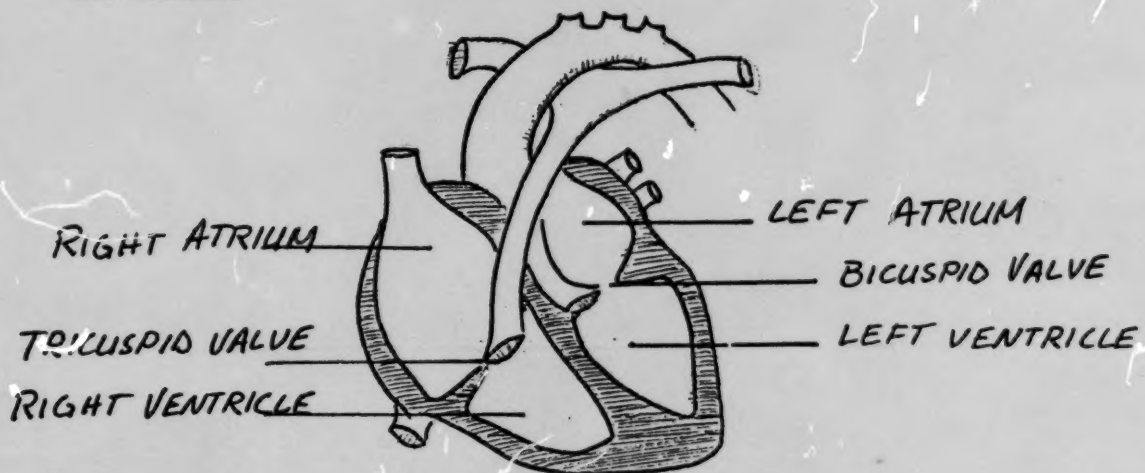
If your drawing agreed with that on Page 3, continue to the next area.

If you did not agree, review this section before continuing.

This is how the heart looks to this point.

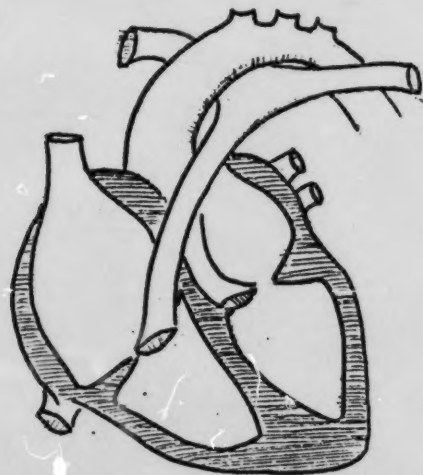


Now you know that the heart is divided into four chambers. As the blood flows from one chamber to another there are valves that prevent the blood from flowing back into the area it just left. The TRICUSPID VALVE prevents backflow of blood from the right ventricle into the right atrium. The BICUSPID VALVE prevents backflow from the left ventricle to the left atrium. Below is an example of where the valves are located.



Practice Question 3

Draw a line from the term on the right to the correct place in the diagram.

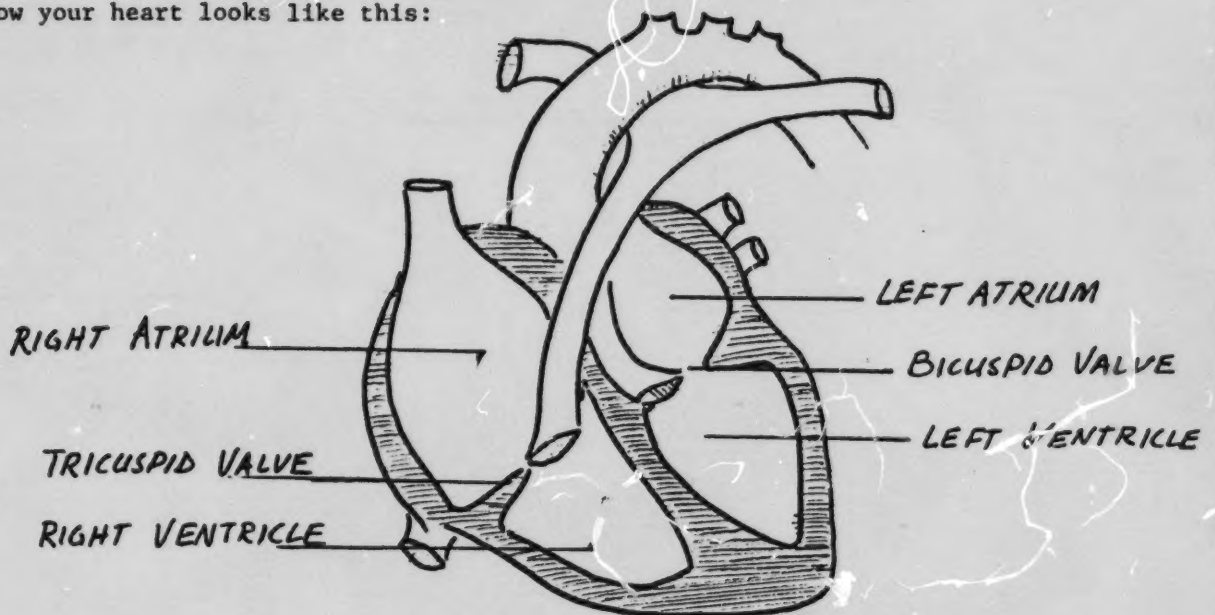


Tricuspid Valve

Bicuspid Valve

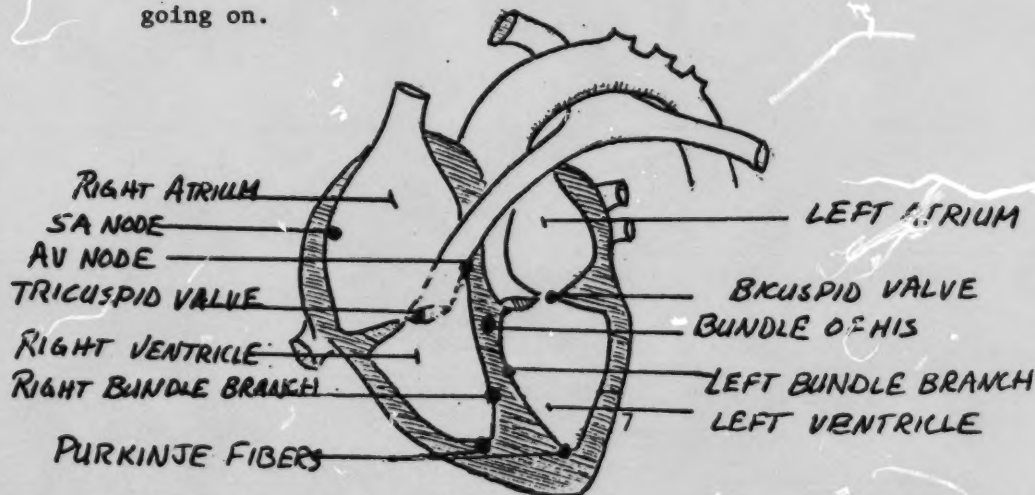
You are correct if your diagram looks like that on Page 5. Continue on to the next section. If you had some doubt as to where the valves were, review this section before continuing.

Now your heart looks like this:



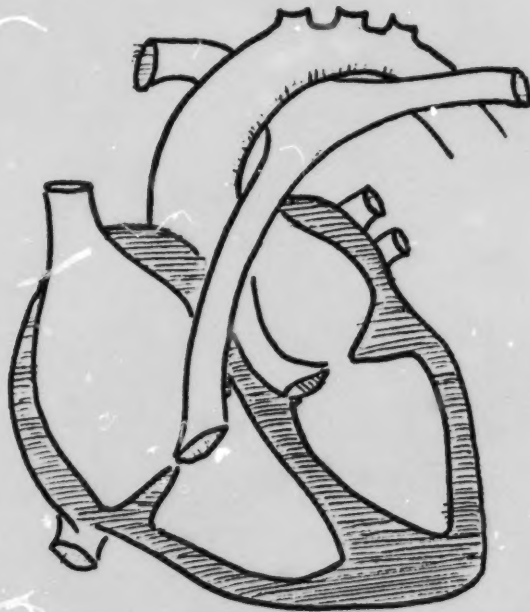
It is time now for us to discuss the conduction system of the heart.

The impulse that causes the heart to contract originates in the S A NODE in the right atrium. The impulse spreads through the atria like the rings that appear when a pebble is dropped in a pond. The impulse next travels through the A V NODE near the junction of the atria and ventricles. Next it continues through the BUNDLE OF HIS below the A V Node. The Bundle of His quickly divides into the RIGHT and LEFT BUNDLE BRANCHES. These Bundle Branches follow the contour of the ventricles and terminate in the PURKINJE FIBERS. The fibers respond to stimulation and this results in cardiac contraction. This is a lot to remember, so study it and the diagram before going on.



Practice Question 4

On the drawing below draw a line from the terms on the right to the correct area of the diagram.



S A Node

A V Node

Bundle of His

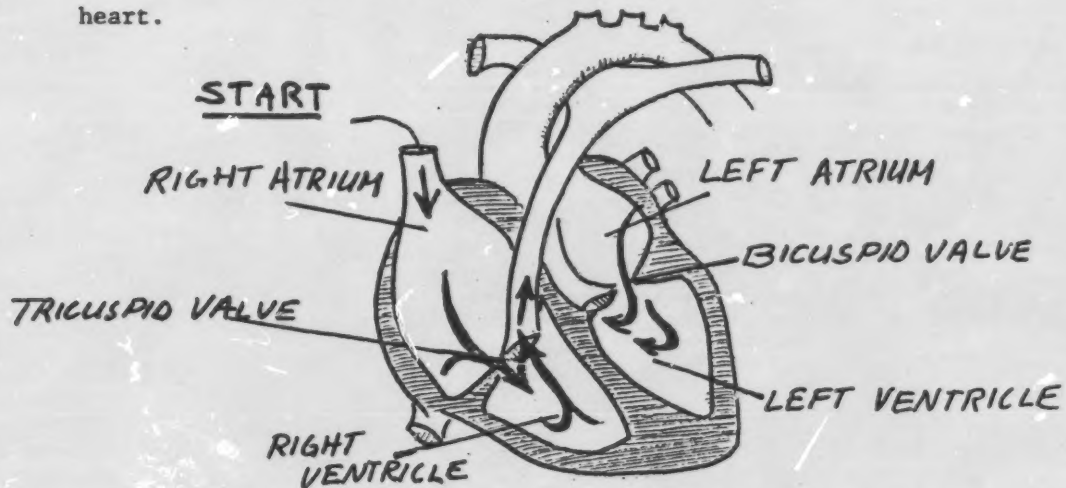
Left Bundle Branch

Right Bundle Branch

Purkinje fibers

Check your drawing with that on Page 7. If yours agrees, you will note that you have a complete diagram of the heart, with all the parts labeled.

On this diagram are arrows to indicate the flow of blood through the heart.



Blood enters the RIGHT ATRIUM. From there it is pumped through the TRICUSPID VALVE into the RIGHT VENTRICLE. The right ventricle pumps it out to the LUNGS. Blood is returned to the LEFT ATRIUM, passes through the BICUSPID VALVE and on to the LEFT VENTRICLE. From there it is sent out to the BODY. Trace the path the blood takes through your heart by following the arrows with your pencil. Begin at start in the right atrium.

Practice Question 5

State how blood flows through the heart.

Your answer should include:

Blood flows through the right atrium into the right ventricle passing through the tricuspid valve. Blood returns from the lungs to the left atrium. It passes through the bicuspid valve into the left ventricle.

Each part of the heart has a special purpose or function. The right and left atria work primarily as collecting vessels for the blood as it flows into the heart.

The ventricles, on the other hand, are the strongest part of the heart and are responsible for pumping blood out of the heart.

The valves that separate the heart chambers are there to prevent the backflow of blood. They work to keep the blood always flowing in a forward direction.

The conduction system is the pathway that the impulse travels to make the heart contract. Certain cells within the heart act to spread the impulse on to the ventricles. The purpose of the conduction system is to transmit (carry) the impulse to the ventricles so that contraction can occur.

Practice Question 6

Think about your heart. Write down the function of the following:

- a. The atria
- b. The ventricles
- c. The valves
- d. The conduction system

If you answered that the atria act primarily as collecting vessels and that the ventricles primarily pump blood you have answered correctly. The valves prevent blood from flowing back from one area of the heart to another. The conduction system is responsible for transmitting the impulse from the S A Node in the right atrium to the Purkinje Fibers in the ventricles.

I believe that you are now ready for the post test. Please turn to it and begin.

POST TEST

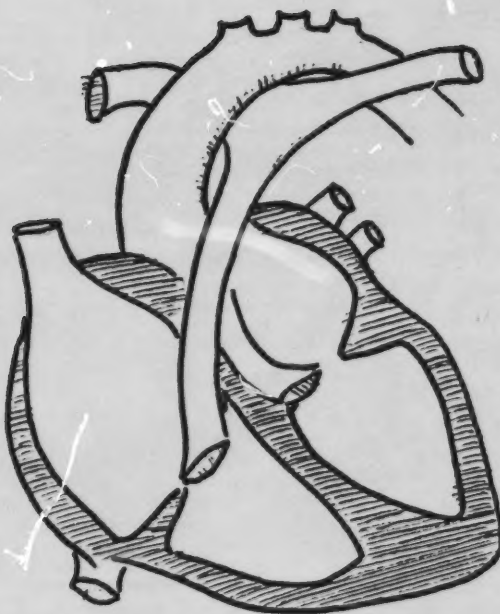
1. Become aware of your heart. What do you think is the main function of your heart?
2. Think of your circulatory system as a vast network of pipes through-out your body. The function of this system is to carry food and oxygen to the body tissues. True or False. (Circle the correct answer).
3. On the next page is a heart.
From the terms listed at the top of the page, label the diagram.
4. Pretend that you are a red blood cell. State the structures you would pass as you travel through the heart.
 - 1)
 - 2)
 - 3)
 - 4)
 - 5)
 - 6)
5. The various parts of the heart have a different purpose. Write the function of the following:
atria
ventricles
valves
conduction system
6. What I liked least of all about this packet was...
7. What I liked best of all about packet was...

POST TEST con't

3.

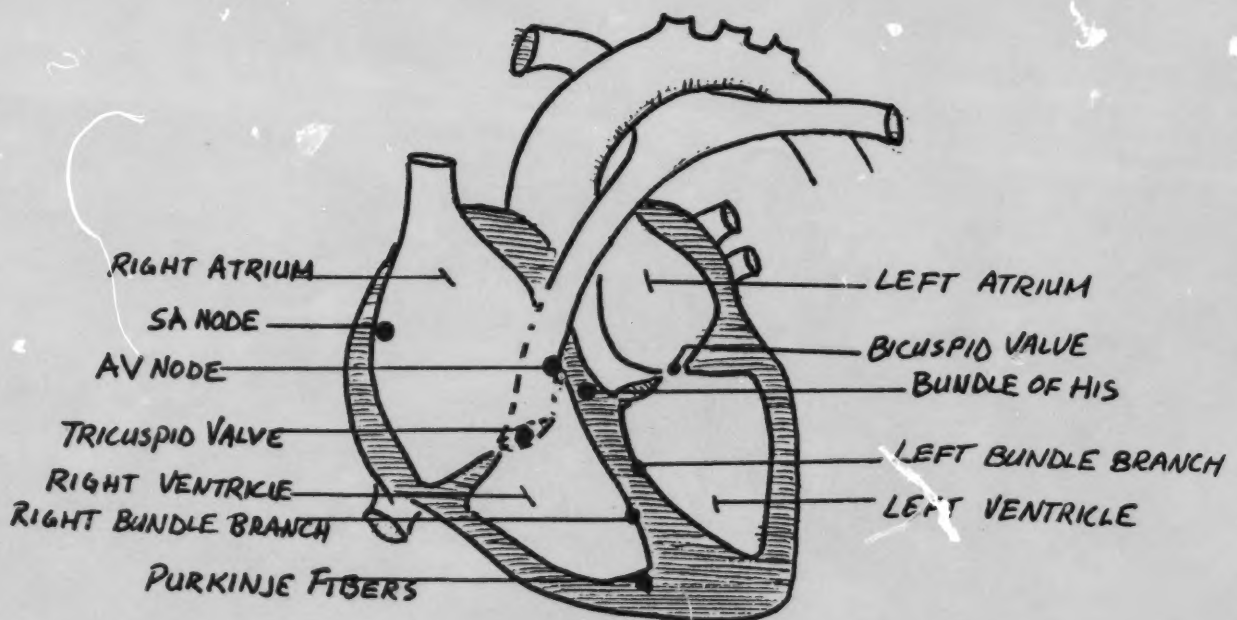
TERMS

S A NCDE
A V NODE
BUNDLE OF HIS
RIGHT BUNDLE BRANCH
LEFT BUNDLE BRANCH
RIGHT ATRIUM
RIGHT VENTRICLE
LEFT ATRIUM
LEFT VENTRICLE
TRICUSPID VALVE
BICUSPID VALVE
PURKINJE FIBERS



ANSWERS TO POST TEST

1. The main purpose of the heart is to act as a pump.
2. True
3. See the drawing below.
4. A red blood cell would pass through:
the right atrium
tricuspid valve
right ventricle
left atrium
bicuspid valve
left ventricle
5. The atria function to collect blood.
The ventricles' function is to pump blood.
The valves work to prevent the backflow of blood.
The conduction system sends the impulse through the heart so that the heart will contract.



ANSWER SHEET FOR POST-TEST

1.

2. ☐ True ☐ False

3.



4. 1)

4)

2)

5)

3)

6)

5. atria -

ventricles -

valves -

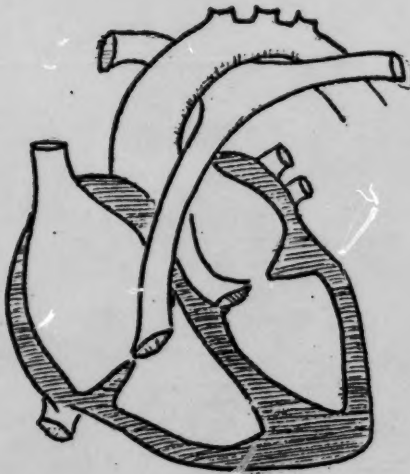
conduction system -

6.

7.

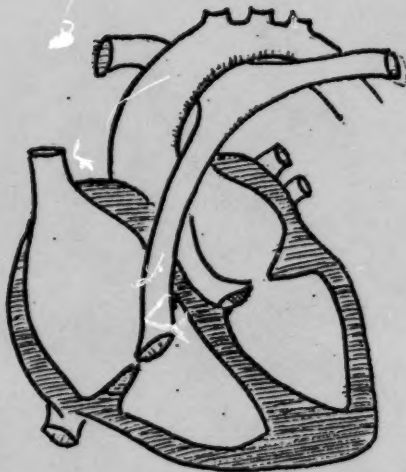
ANSWER SHEET FOR PRACTICE QUESTIONS

- 1.) ____ works as pump
____ to help you breathe better
____ to filter out waste products
- 2.) ____ food ____ oxygen ____ bones
____ heat ____ hair
- 2.



Right atrium
Right ventricle
Left atrium
Left ventricle

3.



Tricuspid Valve
Bicuspid Valve

Practice Questions (cont)

4.



S A Node

A V Node

Bundle of His

Left Bundle Branch

Right Bundle Branch

Purkinje fibers

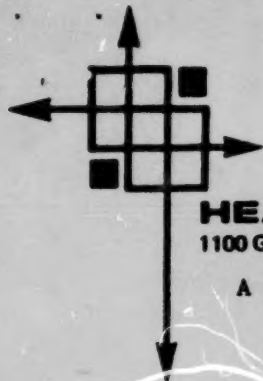
5.

6. a.

b.

c.

d.



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DISORDERS OF CARDIAC CONDUCTION

PART II - ATRIOVENTRICULAR CONDUCTION

By

Mary E. Gotelli, R.N.

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TITLE OF PACKAGE:

Disorders of Cardiac Conduction
Part II - Atrioventricular Conduction

AUTHOR:

Mary E. Gotelli, R.N.

INSTITUTION:

San Joaquin General Hospital,
Stockton, California

INTENDED STUDENTS:

Nurses (R.N.) or technicians
interested in cardiac arrhythmia
recognition.

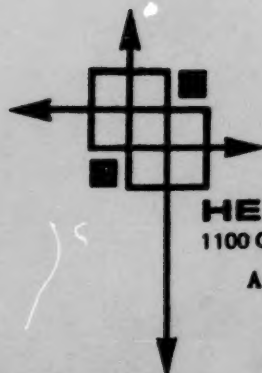
ESTIMATED WORKING TIME:

40 minutes

MATERIALS NEEDED:

none

FIELD TEST COPY



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INTRODUCTION

Hello! So you are having trouble with arrhythmia recognition? You are not alone....other nurses and ECG technicians have the same trouble. This unit of instruction is designed to give you an overview of Atrio-ventricular Conduction. In addition, you will have mastered one of the troublesome areas of arrhythmia recognition.

To gain the most from the information presented, you should first complete Part I: Sino-atrial Conduction.

TURN THE PAGE TO READ ALL THE THINGS YOU ARE GOING TO DO!

Have fun!

OBJECTIVES OF UNIT

Overall Objective

To complete a brief summary of the four types of Atrioventricular (A-V) conduction disorders, illustrating criteria (ECG) for each, probable cause, and suggested treatment.

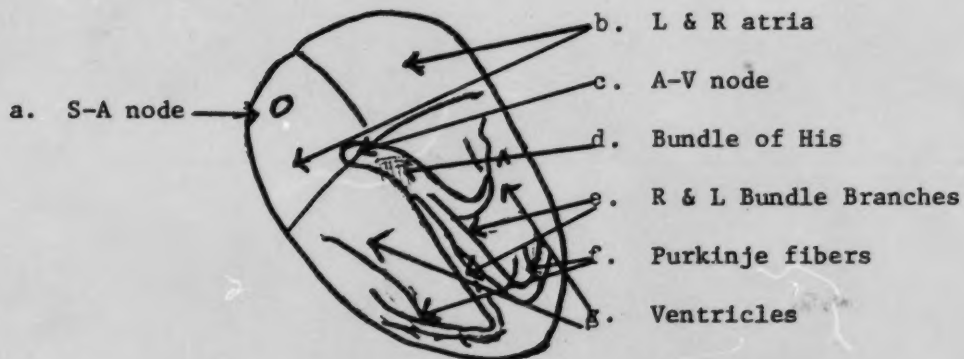
Sub-Objectives

1. Illustrate normal conduction by a simple diagram.
2. Describe A-V node briefly; location, blood supply, its role in the conduction system and some symptoms of ischemia.
3. List four types of A-V conduction disorders, writing a differential explanation between 3^o Heart block with complete A-V dissociation and A-V dissociation.
4. State criteria for ECG recognition of each and illustrate by simple sketch.
5. Give a cause for each degree of A-V block and name for each type of block, plus a corrective action.
6. Express interest in pursuing by topic by proceeding to Part III "Bundle Branch Blocks."

PRACTICE EXERCISE #1

INPUT:

In normal conduction the S-A node initiates the electrical impulse which spreads through both atria, the A-V node, Bundle of His, Bundle Branches through Purkinje fibers to depolarize both ventricles. The A-V node, or actually the surrounding junctional tissue, acts as a delaying station to provide time for adequate cardiac filling. This time lapse is viewed on the ECG within the P-R interval which should not exceed .20 seconds. A beginning A-V block will cause the P-R interval to lengthen.



PRACTICE QUESTION #1

Please reproduce the above diagram depicting normal conduction sequence numbering the parts of the system in proper order.

PRACTICE EXERCISE #1

FEEDBACK:

You have correctly responded to your instructions for Practice Exercise #1 if you listed the conduction sequence as:

1. S-A node
2. Atria
3. A-V node
4. Bundle of His
5. Bundle branches (right and left)
6. Purkinje fibers
7. Ventricles

CONGRATULATIONS!! Please proceed to Practice Exercise #2.

PRACTICE EXERCISE #2

INPUT

The A-V node measures about 1 x 3 x 6 mm and is located in the lower interatrial septum near its junction with the membranous interventricular septum. Approximately 90% of people's blood supply for the A-V node comes from the right coronary artery. In the other 10% of the population, blood supply comes from the left circumflex artery. The A-V node acts as a relay station delaying conduction briefly.

An area of vagal neuroreceptors located very close to the A-V node may be stimulated when the node is injured or ischemic. This may explain why ischemia of the A-V node is often associated with an intense vagal discharge resulting in nausea, vomiting, bradycardia, or syncope.

PRACTICE EXERCISE #2 (Cont.)

Disease or abnormalities of the A-V node usually slow A-V conduction but occasionally may also accelerate it as in the Wolfe-Parkinson-White Syndrome. (To learn more about this arrhythmia you may refer to Part IV, "Problems of Accelerated Conduction" or Mary Conover's "Understanding Electrocardiography," 1976 - C.V. Mosby Co.)

Practice Question #2

Please fill in the blanks.

- 1) The A-V node is located in the _____.
- 2) 90% of the population receive blood supply to their A-V node from the _____ artery; the remainder receive their blood supply to the A-V node from the _____ artery.
- 3) The _____ acts as a conduction relay station.
- 4) _____ and _____ are two results of ischemic A-V Nodal tissue.

Practice Exercise #2 (continued)

Feedback

The following answers should help you evaluate your progress:

1. A-V node is located in the interatrial septum.
2. 90% people - blood supply to the A-V node is provided by the right Coronary Artery.
10% people - blood supply to the A-V node is provided by the left Circumflex artery
3. A-V node acts as a conduction relay station.
4. Bradycardia and Nausea are two results of ischemic A-V nodal tissue.

If you missed more than one item, PLEASE review pages 4 & 5 before continuing with the next exercise.

If your answers to Practice Exercise #2 are CORRECT,

S P L E N D I D !!!!!!!

Proceed to Practice Exercise #3

PRACTICE EXERCISE #3

There are four types of A-V conduction disorders. They are:

- 1) 1° heart block (1° HB)
- 2) 2° heart block - Mobitz type I (Wenckebach phenomenon)
2° heart block - Mobitz type II
- 3) 3° heart block with complete A-V dissociation
- 4) A-V dissociation.

In 1° HB (Fig. I) you will note the P-R interval is prolonged.

Other components of
the cardiac cycle

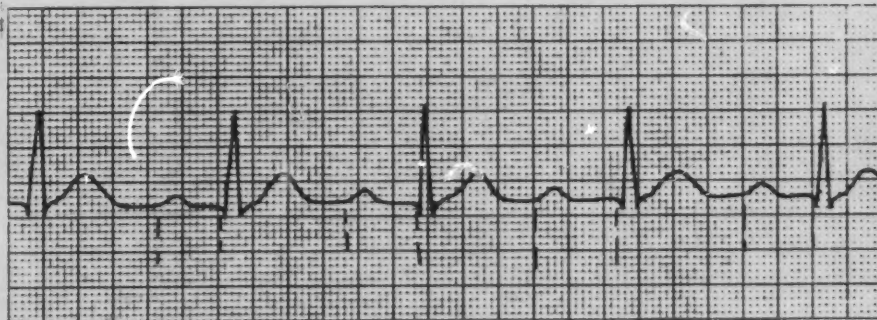
are normal. A

normal P-R interval

is .12 sec. to .20

seconds.

Normal rhythm with a first-degree heart block



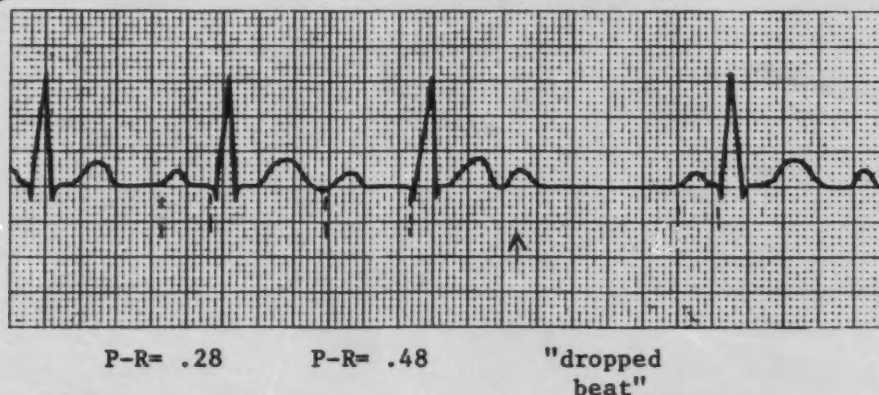
P-R = .36 seconds.

PRACTICE EXERCISE #3 (Cont.)

There are two types of 2° HB: Mobitz Type I (Wenckebach's phenomenon) - see Fig. II, and Mobitz Type II (Fig. III). Mobitz Type I occurs above the His bundle. Each P-R interval becomes progressively longer until a "dropped beat" occurs, then the pattern is repeated.

Mobitz type I second-degree heart block (Wenckebach's phenomenon)

II



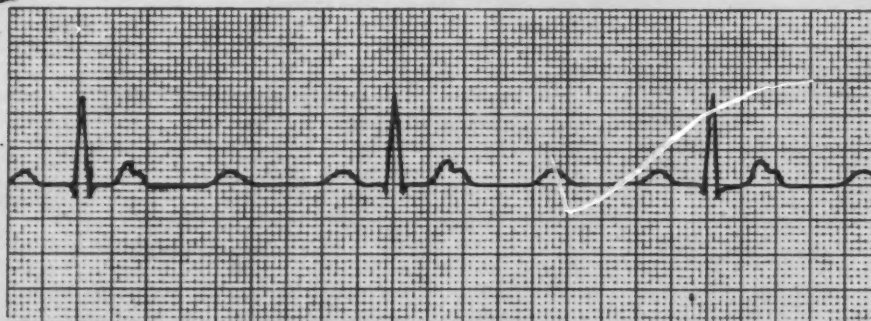
Suspect a Wenckebach phenomenon when you see repetitious groupings of beats.

Mobitz Type II 2° HB occurs below the His bundle and is a more ominous arrhythmia. It is characterized by a fixed P-R interval and the non-conducted

AV conduction with Mobitz type II second-degree heart block

beats occur without warning.

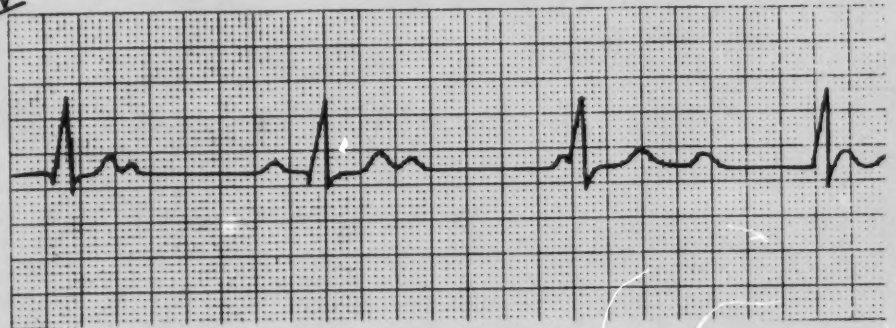
III



PRACTICE EXERCISE #3 (Cont.)

3° HB with complete A-V dissociation (Fig. IV) shows INDEPENDENT or DISSOCIATED atrial or ventricular conduction. P waves show no relationship to QRS complexes. P waves occur regularly at their inherent rate and idio-nodal or idio-ventricular QRS complexes occur at their slow rate.

IV Complete AV dissociation with third-degree heart block

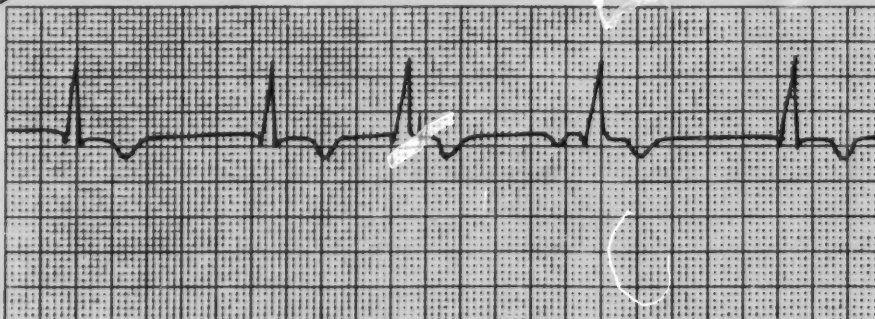


P waves = rate of 72 QRS rate = 43

"A-V dissociation" should be reserved for the arrhythmia in which atria and ventricles are controlled by independent pacemakers, but capacity for forward A-V conduction is only incompletely blocked.

The arrhythmia is usually transient.

AV dissociation



PLEASE TURN TO PRACTICE QUESTION #3.

PRACTICE QUESTION #3

1) List four types of A-V conduction disorders.

2) A-V dissociation, like 3° HB is characterized by independent atrial and ventricular pacemakers, but unlike 3° HB, the forward A-V conduction is _____ blocked.

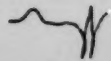
3) Draw simple sketches to illustrate an important ECG criterium for each type of arrhythmia.

Feedback:

You have correctly understood Exercise #3 if you listed:

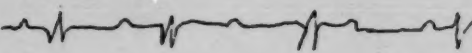
- 1) A. 1° HB
 - B. 2° HB - Mobitz I - Wenchebach
 - 2° HB - Mobitz II
 - C. 3° HB with complete A-V dissociation
 - D. A-V dissociation
- 2) In A-V dissociation, A-V conduction is INCOMPLETELY blocked.

3) 1° HB



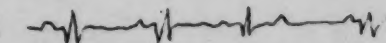
Prolonged P-R interval.

2° HB I



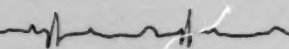
Progressive prolongation of P-R interval until "dropped" beat occurs.

2° HB II



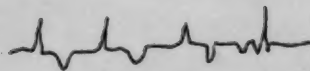
Fixed P-R interval with unexpected "dropped" beat.

3° HB



Independent pacemakers in atria and ventricles. No relationship between P waves and QRS complexes.

A-V dissociation



Independent pacemakers in Atria and ventricles, but forward A-V conduction intact or completely blocked.

PLEASE STRUGGLE ON TO EXERCISE #4. YOU ARE DOING VERY WELL!!!

PRACTICE EXERCISE #4

A-V Conduction Defect	Characteristics	Probable Causes	Suggested Treatment
1° HB	Prolonged P-R interval	Drug toxicity (Digitalis?) Underlying cardiac disease.	Document rhythm strip. Determine if drug-related and stop drug. Observe for further progression of block.
2° HB Mobitz I (Wenchebach)	Progressive prolongation of P-R interval until a "dropped" beat occurs.	Drug toxicity (Digitalis?) Ischemia from inferior myocardial infarction. Underlying cardiac disease Viral diseases.	Document rhythm strip. Determine if drug-related and stop drug. Observe for further progression of block. (Usually transient, but does respond to drug therapy.)
2° HB Mobitz II	"Fixed" P-R interval with "dropped" beats occurring unexpectedly without warning. Perhaps only every 2nd, 3rd, or 4th P wave is conducted to ventricles.	Drug toxicity Ischemia from anterior myocardial infarction Underlying cardiac disease	Document rhythm strip. Determine if drug-related and stop drug. Have transvenous pacemaker on hand for placement. Observe for further progression of block.
3° HB with complete A-V dissociation.	Independent atrial and ventricular pacemaker. P wave has no relationship to QRS complex.	Drug toxicity Congenital block Ischemia Trauma	Document rhythm strip. May require insertion of transvenous pacemaker. Observe carefully.
A-V dissociation	Independent atrial and ventricular pacemakers. Forward A-V conduction is intact or only incompletely blocked.	Digitalis toxicity (Most frequent cause.)	Document rhythm strip. Treat underlying cause. Usually transient to no treatment necessary.

PRACTICE QUESTION #4

List one cause for each degree of A-V block and give a corrective action.

	<u>Cause</u>	<u>Corrective Action</u>
1° HB	_____	_____
2° HB-I	_____	_____
2° HB-II	_____	_____
3° HB	_____	_____
A-V Dis- sociation	_____	_____

PLEASE COMPARE YOUR ANSWERS WITH THE FORMAT IN PRACTICE EXERCISE #4.

If they are correct.....YOU have successfully completed this unit of instruction.....

EXCEPT.....

for the POST-TEST, which you are certain to SUCCEED WITH!

POST-TEST

1. Draw a simple diagram to illustrate normal conduction labeling the seven parts in proper sequence.

2. Match the most appropriate Right column items with the letters in the Left column.

a. _____ A-V node	I. supplies A-V node blood in 10% of patients.
b. _____ Rt. coronary artery	II. a symptom of ischemic A-V node
c. _____ Lt. circumflex artery	III. conduction delay station
d. _____ bradycardia	IV. supplies A-V node blood in 90% of patients.
e. _____ nausea	V. hypoxic vagal response
	VI. disease of A-V node
	VII. lower, interatrial septum.

3. a. List four A-V conduction disorders.

- b. Write an explanation to differentiate complete A-V dissociation with 3° HB and A-V dissociation briefly.

- c. State criteria for identification by ECG of these A-V conduction abnormalities and illustrate with simple sketches.

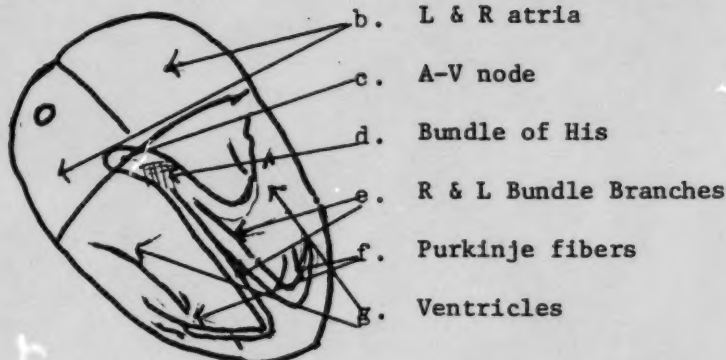
4. List a cause for each degree of A-V block and name a corrective action for each arrhythmia.

5. If completion of this brief self-instructional package has interested and challenged you please express this by proceeding to Part II "Bundle Branch Blocks."

ANSWERS TO THE POST-TEST

1.

a. S-A node



b. L & R atria

c. A-V node

d. Bundle of His

e. R & L Bundle Branches

f. Purkinje fibers

g. Ventricles

2. a. III & VII

b. IV

c. I

d. II

e. II

3. a. 1° A-V block

2° A-V block Type I (Wenchebach)

2° A-V block Type II (Mobitz)

3° A-V block - complete (with dissociation)

A-V dissociation.

b. The term A-V dissociation should be reserved for instances in which the atria and ventricles are controlled by independent pacemakers. The capacity for forward A-V conduction is intact or only partially blocked.

3° A-V block is an example of complete A-V dissociation.

1° A-V block - normal conduction is present, i.e., P wave precedes each QRS; QRS duration is within normal limits; P-R interval is prolonged beyond 0.20 seconds.

2° A-V block - Mobitz Type I or Wenchebach's phenomenon is characterized by progressive lengthening of the P-R interval for several successive beats until a "dropped" beat occurs. (P wave which is not followed by a QRS.)

ANSWERS TO POST-TEST (Cont.)

(2° A-V block, Mobitz Type I or Wenchebach's phenomenon - continued)

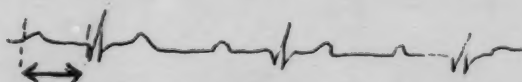
This should be suspected whenever there are groupings of several beats identically repeated in the same sequence.

R to R intervals become progressively shorter; repolarization events are normal.

2° A-V block, Mobitz Type II is characterized by sudden failure of A-V conduction so that only every 2nd, 3rd, or 4th atrial impulse is conducted to the ventricles; P-R intervals are constant in conducted beats and QRS durations are normal unless there is associated Bundle Branch Block (BBB).

3° A-V block - or complete heart block - produces an ECG display of independent atrial and ventricular activity. P waves occur at regular intervals at sinus rates. QRS complexes may be fairly normal in morphology if control is at the junctional area (at inherent junctional rates) or broad beyond normal limits if ventricular ectopic focus is in control.

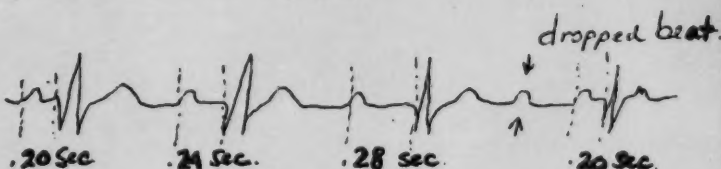
3. c. 1° A-V block



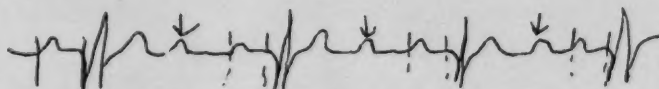
P-R interval longer than .20 seconds.

2° A-V block

Type I - Wenchebach



Type II- Mobitz



P-R intervals constant at .24 sec.
decrease non-conducted beats.

3° A-V block - complete heart block



Idioventricular rhythm at rate .35 seconds;
Atrial rhythm at 68 - no relationship between
atrial and ventricular activity.

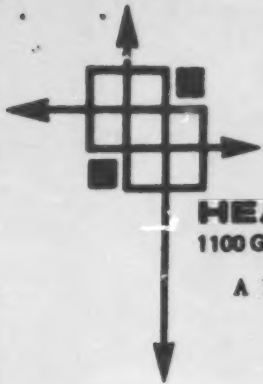
ANSWERS TO POST-TEST

(Continued)

4. Causes: - 1° HB = drug toxicity (digitalis); underlying cardiac disease
- 2° HB = rheumatic fever; digitalis; inferior myocardial infarction
Type I
- 2° HB = digitalis and quinidine toxicity; anterior myocardial infarction
Type II
- 3° HB = congenital block; ischemia; drugs; trauma

Treatment:

- 1° HB = Document rhythm strip
Check for drug toxicity and if applicable, withhold next dose
Watch patient.
- 2° HB = Document with rhythm strip.
Identify type:
If I - watchfulness and drugs
If II - transvenous pacemaker
Check for drug toxicity, etc.
Have transvenous pacemaker with materials for insertion on hand.
- 3° HB = Document rhythm strip.
Determine etiology -
- if chronic - can wait for cardioversion or drug therapy
- if acute - as result of infarction
- may require countershock or insertion of pacemaker



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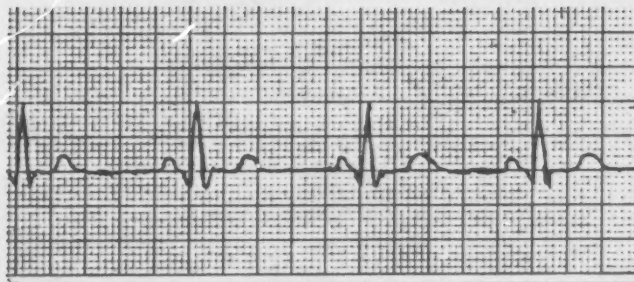
A PROJECT OF THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE

BASIC ELECTROCARDIOGRAPHY:

The Electrical
Anatomy of the Heart

By

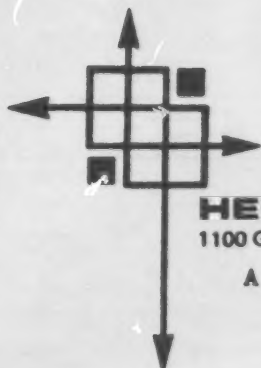
Sharilyn Robinson



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TITLE OF PACKAGE:	Basic Electrocardiography: The Electrical Anatomy of the Heart
AUTHOR:	Sharilyn Robinson
INSTITUTION:	Maricopa Technical Community College, Phoenix, Arizona
INTENDED STUDENTS:	Registered nurses, licensed practical nurses, paramedics
ESTIMATED WORKING TIME:	30 minutes
MATERIALS NEEDED:	None
REVISED:	August 1, 1977

NOTE: A basic understanding of the anatomy and physiology of the heart is prerequisite to this unit. If the student has never seen an electrocardiograph machine, he should briefly be shown one before starting the unit.



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INTRODUCTION

This lesson unit is intended for professionals and paraprofessionals in the health field.

Primarily, it is designed for registered nurses and licensed practical nurses who have not had any exposure to electrocardiography in their education or work.

This unit could also be used by nursing students who are beginning study in the area of electrocardiography, and by paramedical personnel, such as physicians' assistants or emergency personnel.

The student must have a basic understanding of the anatomy and physiology of the heart. He/she must know the location of the heart, what type of tissue the heart primarily consists of, the primary function of the heart, and what direction the blood flows and why.

Directions:

Answers for the questions in this learning unit are at the right hand side of each page. Cover that answer column as you begin each page. Then uncover each answer to check yourself after you've answered each question.

OBJECTIVES OF UNIT

After you have completed this unit, you will have a fundamental understanding of how the heart is stimulated to beat and how these activities are represented on an electrocardiograph tracing.

- Given a list of terms -S-A node, atrial muscle, A-V node, bundle of His, bundle branches, Purkinje fibers, ventricular muscle - you will list the order in which these structures are activated during a normal heart beat.
- Given an anatomical drawing of a human heart, you will label specific structures of the heart.
- Given a normal EKG tracing, you will label the P-wave, the QRS complex, and the T-wave.
- You will write a definition of the term electrocardiogram that includes the basic terms of depolarization and repolarization.

1. In order for the heart to function effectively as a pump, the heart muscle must contract in an orderly and rhythmic manner.

orderly
rhythmically

An effective heart beats _____ and _____.

2. An orderly, effective, rhythmic contraction of heart muscle begins due to an electrical impulse conducted through the heart.

an
electrical
impulse

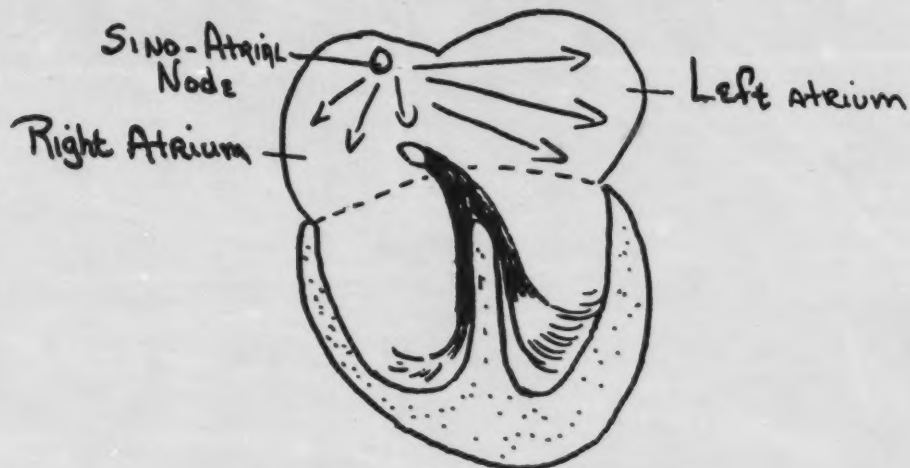
What causes the cardiac muscle to contract?

3. This electrical impulse must follow a special pathway for the heart to beat effectively.

orderly
rhythmic
electrical
impulse
special
pathway.

An effective heart beat is _____ and _____, is initiated by an _____, and follows a _____.

4. The electrical impulse originates in a specialized area of the right atrium called the Sino-Atrial Node and then immediately spreads through the right and left atrium in a regular pattern (See Diagram).



The electrical impulse begins in _____ and immediately spreads through _____ and _____.

Sino-Atrial Node

Right & Left Atrium

5. The Sino-Atrial Node (also abbreviated S-A Node) is called the "pacemaker" or battery of the heart as it originates the heart beat and regulates the heart rate.

Heart rate is controlled by the _____.

Sino-Atrial Node

6. The pulse rate of the human heart is controlled by the _____ which is also called the _____ of the heart.

Sino-Atrial Node

pacemaker

7. This electrical stimulus from the Sino-atrial Node causes the atria to contract in an orderly and rhythmic manner

Electrical im-
pulse from the
Sino-Atrial
Node

What initiates muscle contraction of the atria?

8. An electrical impulse to any muscle causes it to contract.
The process of electrical activators causing muscles to contract is called depolarization.

A depolarized muscle is _____.

contracted

9. The process of the atrial contraction is also called depolarization.

Depolarization of the atria is:

- 1) shortening of atria muscle
- 2) lengthening of atria muscle
- 3) complete relaxation of atria muscle

(1)

10. The electrical activities of the heart are transmitted outward to the surface of the body where they can be detected with electrodes (small metal discs).

_____ placed on the skin can detect _____
of the heart.

Electrodes
Electrical
activity

11. It is possible to record the electrical activity of the heart muscle by means of an electrocardiogram machine. An electro/cardio/gram is a recording of the electrical activity of the heart.

electro=electrical activities
cardio=heart
gram=recording

An electrocardiogram is a _____ of the _____ of the heart muscle which is detected when _____ are placed on the _____.

recording
electrical
activities
electrodes
skin

12. The term electrocardiogram is often abbreviated as EKG or ECG.

_____ or _____ means the same as electrocardiogram.

EKG
ECG

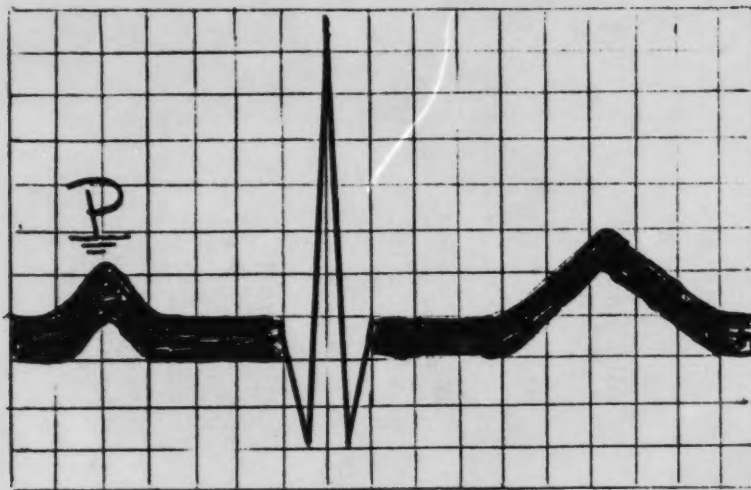
13. Define the term EKG.

Why are electrodes needed to obtain an ECG?

recording of the
electrical
activities of the
heart

to detect the
electrical impulse
of heart on the
surface of the
body

14. The following diagram is a normal EKG recording:



The upright wave (labeled P) represents the electrical activities of atrial contraction.

The P waves represent: A) Stimulation of S-A node
B) Depolarization of atria
C) Repolarization of atria

(B)

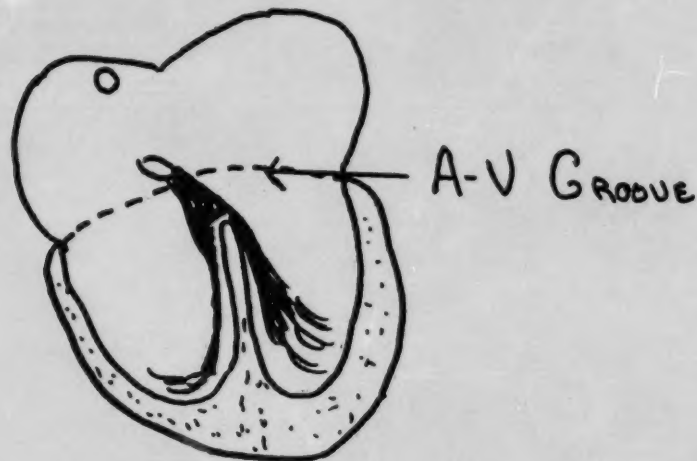
15. An effective heart must beat in an _____ and
_____ fashion.

orderly &
rhythmic

Atrial depolarization is represented on an EKG by the
_____.

P-wave

16. The electrical impulse of the atria does not automatically cause depolarization of the ventricles due to a fibrous band separating the atria and ventricles (See Diagram). The special name for the fibrous band is the A-V groove.



The A-V Groove: A) is essential in the conduction system of the heart

B) is not part of the conduction system of the heart

(B)

C) partially acts in the conduction of the electrical stimuli

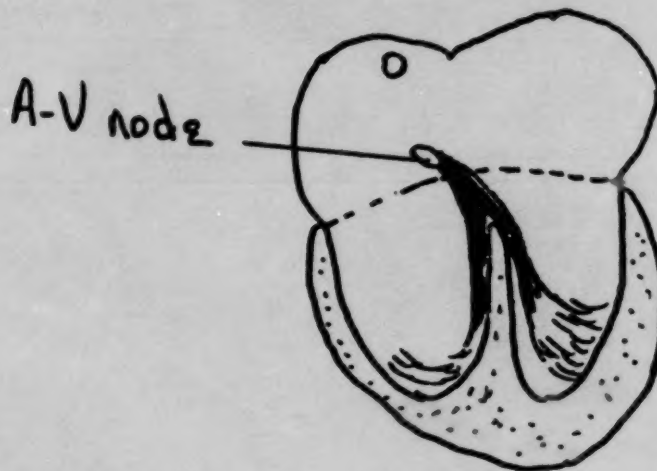
17. Another specialized area of tissue in the right atrium must conduct the electrical impulse to the ventricle. The special area is called the atrio-ventricular node.

The atrio-ventricular node conducts the electrical impulse from the _____ to _____.

atria

ventricles

18. The atrio-ventricular node is also abbreviated the A-V node, and is located in the lower left portion of the right atrium.



- A) Where is the S-A node located?
B) Where is the A-V node located?

Upper right atrium

Lower right atrium

19. Due to a fibrous band called the _____, the _____ node is necessary to conduct the electrical impulse from the _____ to _____.

A-V groove
A-V

atria
ventricles

20. Identify the number structures of the diagram.

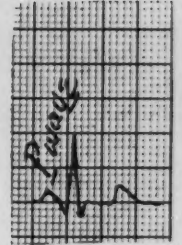
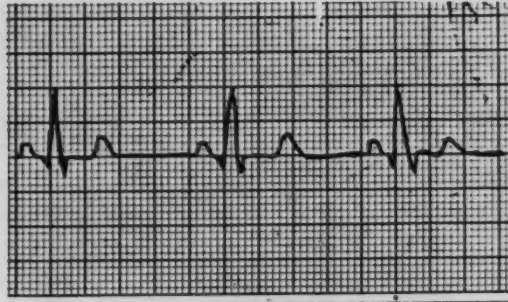


S-A node

A-V groove

A-V node

21. Label the P-waves in the following tracing



Depolarization
of the atria

What does the P-wave represent?

22. The atria push blood down to the ventricles. The ventricles need to push blood upward (See diagram). Therefore the ventricles must contract in an upward motion to be effective.



A downward contraction of the ventricles would be effective/ineffective.

ineffective

23. The A-V node doesn't send the electrical impulse immediately to the ventricles. It sends the electrical impulse downward through a specialized conduction system first.

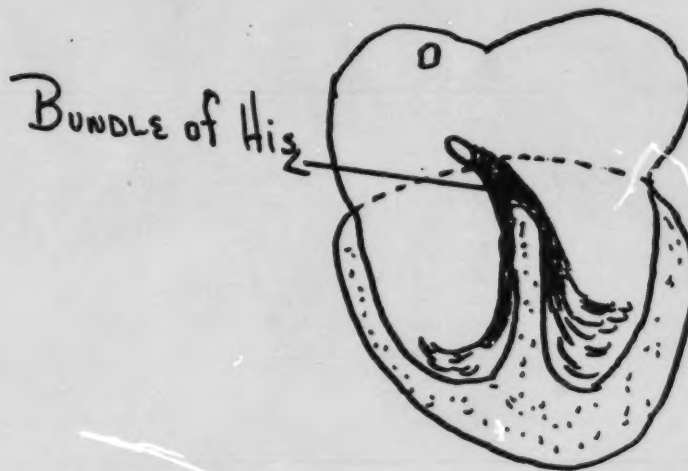
a) S-A node does/does not immediately stimulate the atria to contract.

does

b) A-V node does/does not immediately stimulate the ventricle to contract.

does not

24. The A-V node continues downward between the two ventricles to form the Bundle of His. The Bundle of His is also part of the special conduction system which prevents immediate depolarization of the ventricle. The special conduction system is necessary for the upward contraction of the ventricles.



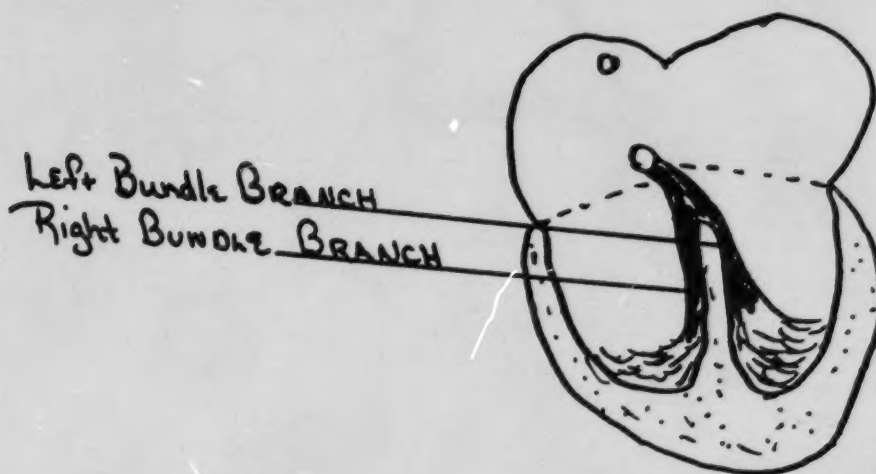
The Bundle of His is a continuation of the _____.

A-V node

Why is the special conduction to the ventricles necessary?

ventricle must contract upward

25. The Bundle of His breaks down into right and left bundle branches which continue to carry the electrical impulse downward through a special conduction system. (see diagram)



The right and left Bundle Branches are a continuation of the _____.

Bundle of His

26. The impulse is conducted from the left and right Bundle Branches to the Purkinje Fibers. The Purkinje fibers have direct contact with ventricle muscular fibers.

Purkinje Fibers



The impulse from the A-V node to _____ to _____
_____ to _____ cause the _____
to be depolarized.

Bundle of His

Bundle Branches

Purkinje Fibers

27. The Purkinje Fibers stimulate the ventricle muscle fibers to contract in an upward orderly manner

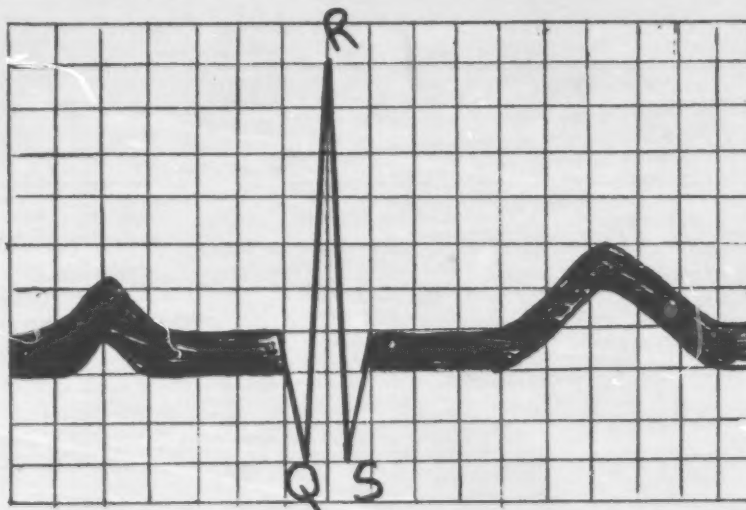
The _____ allow _____ of the ventricle to occur.

Purkinje fibers depolarization

28. List in the order the structures involved in carrying the electrical impulse from the atria to the ventricle.

A-V node, Bundle of His, Bundle Branches, Purkinje fibers.

29. The following diagram is a normal EKG tracing



The downward Q wave, the upward R wave, the downward S wave represent the electrical pattern of ventricle depolarization. The sum of the three waves is called the QRS complex.

A) The P wave represents: a) depolarization of atria b) repolarization of atria, c) depolarization of ventricle.

A = a

B) The QRS complex represents: a) depolarization of atria, b) repolarization of atria, c) depolarization of ventricle.

B = c

30. Number the following structures in the order in which they are activated during a normal heart beat.

_____ bundle branches	_____ atrial muscle
_____ A-V node	_____ bundle of His
_____ S-A node	_____ Purkinje fibers
_____ ventricular muscle	

1-S-A node
2-atrial muscle
3-A-V node
4-Bundle of His
5-bundle branches
6-Purkinje fibers
7-ventricular muscle

31. The P wave represents _____.
The QRS represents _____.

depolarization of atria
depolarization of ventricle

32. Contracted muscle must have a recovery phase before contraction can again occur. The recovery of muscle is termed repolarization.

Contracted muscle is _____.
Relaxing muscle is _____.

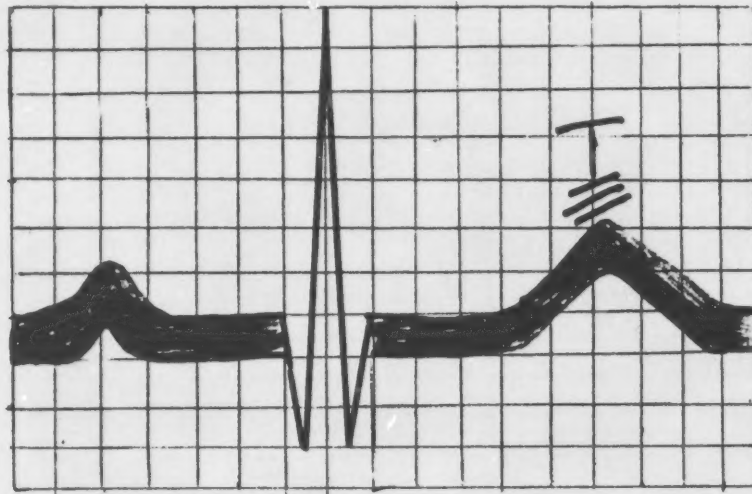
depolarization
repolarization

33. Repolarization like depolarization consists of some electrical activities. Therefore an EKG also records repolarization.

An EKG is _____.
Repolarization is _____.

a recording of the electrical activities of the heart.
recovery phase of depolarized muscle.

34. The following diagram is a normal EKG tracing:



The T wave represents repolarization of the ventricle.

The P waves _____.

The QRS complex _____.

The T wave _____.

Represents atria depolarization

Represents ventricle depolarization.

Represents ventricle repolarization.

35. During the process of _____, muscle fibers are _____.

repolarization
recovering

During the process of _____, muscle fibers are _____.

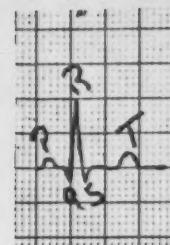
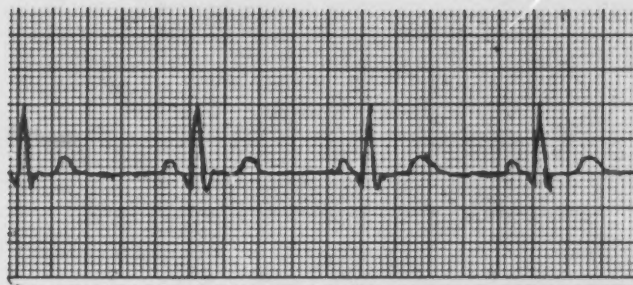
depolarization
contracting

36. Repolarization of the atria also occurs. However it is not evident on the EKG as the depolarization of the ventricle occurs simultaneously with repolarization of the atria.

Repolarization of the atria is/is not represented on an EKG.

is not

37. In the following tracing, label and define each part.



P wave - depolarization of atria

QRS complex - depolarization of ventricle

T wave - repolarization of ventricle.

What cardiac activity is not shown represented in the above EKG tracing?

Atrial repolarization.

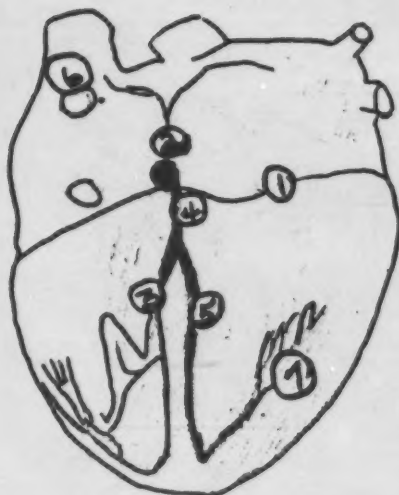
38. What is an EKG tracing?

A recording of the electrical activities of the heart.

Specifically what does an EKG tracing represent?

depolarization of atria.
depolarization of ventricle.
repolarization of ventricle.

39. Label all the structures numbered in the following drawing:



1- A-V groove

2- A-V node

3- right bundle
branch

4- Bundle of His

5- left bundle
branch

6- S-A node

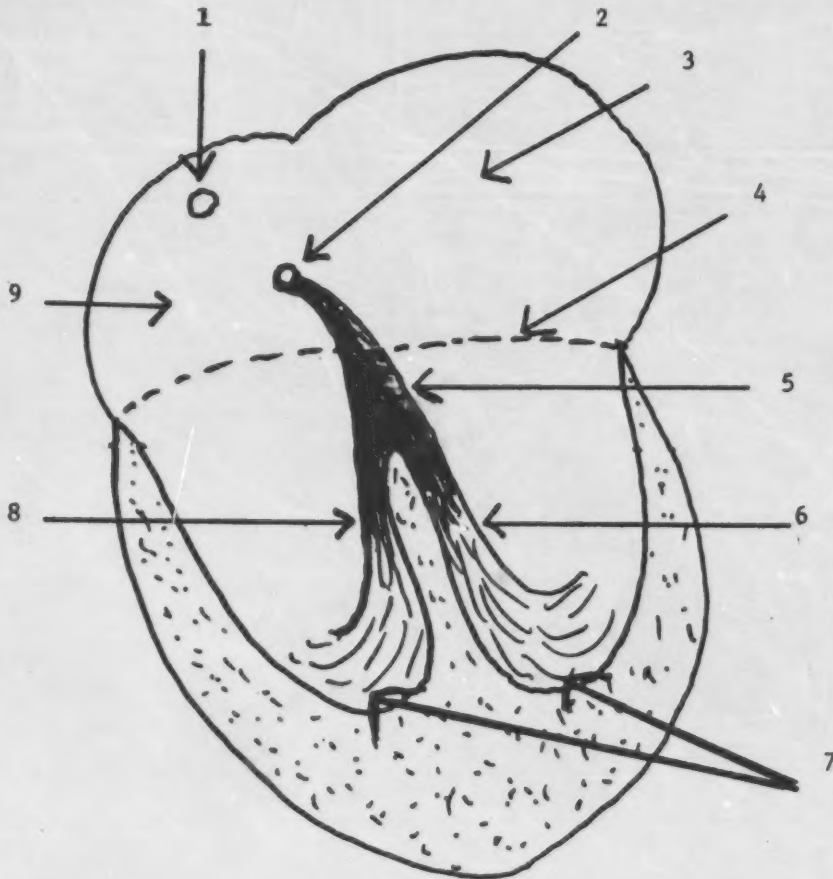
7- Purkinje fibers

POST-TEST

1. Number the following structures in the order in which they are activated during a normal heart beat.

_____ Atrial muscle	_____ Bundle of His
_____ Purkinje fibers	_____ A-V node
_____ Bundle branches	_____ S-A node
_____ Ventricular muscle	

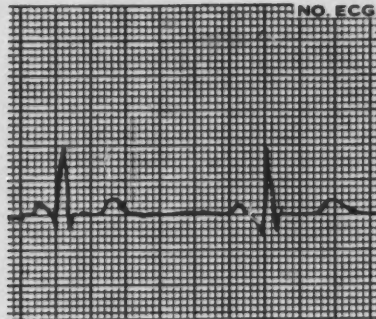
2. Name all the numbered structures in the following drawing.



- (1) _____
- (2) _____
- (3) _____
- (4) _____
- (5) _____
- (6) _____
- (7) _____
- (8) _____
- (9) _____

POST-TEST (cont.)

3. Label every P-wave, every QRS complex, and every T-wave in the following EKG tracing.



4. Give a thorough definition of the term electrocardiogram.

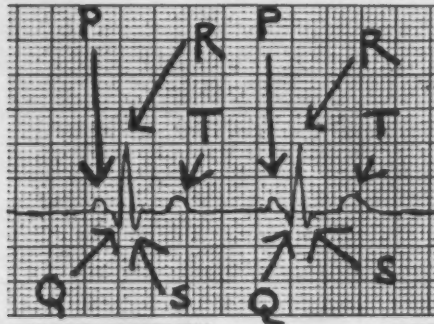
When you have finished, turn the page for the answers to the Post-Test.

ANSWERS TO POST-TEST

1. 2 Atrial muscle 4 Bundle of His
 6 Purkinje fibers 3 A-V node
 5 Bundle branches 1 S-A node
 7 Ventricular muscle

2. (1) S-A node
 (2) A-V node
 (3) Left atrium
 (4) A-V groove
 (5) Bundle of His
 (6) Left bundle branch
 (7) Purkinje fibers
 (8) Right bundle branch
 (9) Right atrium

3.



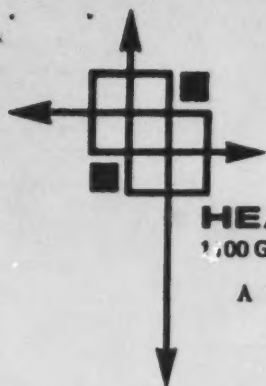
4. An electrocardiogram, also known as EKG or ECG, is a graphic record of the heart's action; a tracing, on paper, showing the electrical activity activity of the heart muscle.
- Electrodes, attached to the skin, are used to detect electrical impulse of the heart at the surface of the skin.

ANSWERS TO POST-TEST (cont.)

4. (cont.)

An EKG records both depolarization and repolarization of the heart muscle. The activity of the heart is shown on a tracing; these readouts show P-waves, T-waves, and QRS complex waves, and they graphically depict the heart's action.

I'm sure your wording of a definition for an electrocardiogram is different from mine. However, if it contains basically the same information -- consider your answer correct.



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EVENTS OF THE CARDIAC CYCLE

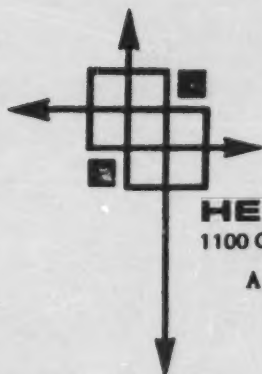
By

William C. Buskirk, Ph.D.

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TITLE OF PACKAGE:	Events of the Cardiac Cycle
AUTHOR:	William C. Buskirk, Ph.D.
INSTITUTION:	Lane Community College, Eugene, Ore.
INTENDED STUDENTS:	Anatomy and Physiology
ESTIMATED WORKING TIME:	35 minutes
MATERIALS NEEDED:	Heart model or diagram
REVISED:	October 1, 1977

Prerequisite: Knowledge of anatomical structures
of the heart.



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Overall Objective

Your overall objective is to be able to describe sequential events in the cardiac cycle, in order to understand the functioning of the heart muscle and heart valves at each point in the cycle.

Sub-Objectives

1. Describe the causes of ventricular filling.
2. Describe the effects of ventricular filling.
3. Describe the effects of atrial contraction.
4. Describe the effects of ventricular contraction on the action of the heart valves and the emptying of the ventricles.
5. Describe the effects of ventricular contraction on arterial blood pressure and atrial filling.
6. Describe the events causing the heart sounds.
7. Given a graph showing the changes in blood pressures, ventricular volume, and heart sounds that occur during the cardiac cycle, be able to describe the functioning of the heart muscle and heart valves at any point in the cycle.

Introduction

This package assumes that you have learned the anatomical structures of the heart, and have at least a general idea of the mechanisms causing flow of blood through the heart. The package should help you correlate these mechanisms.

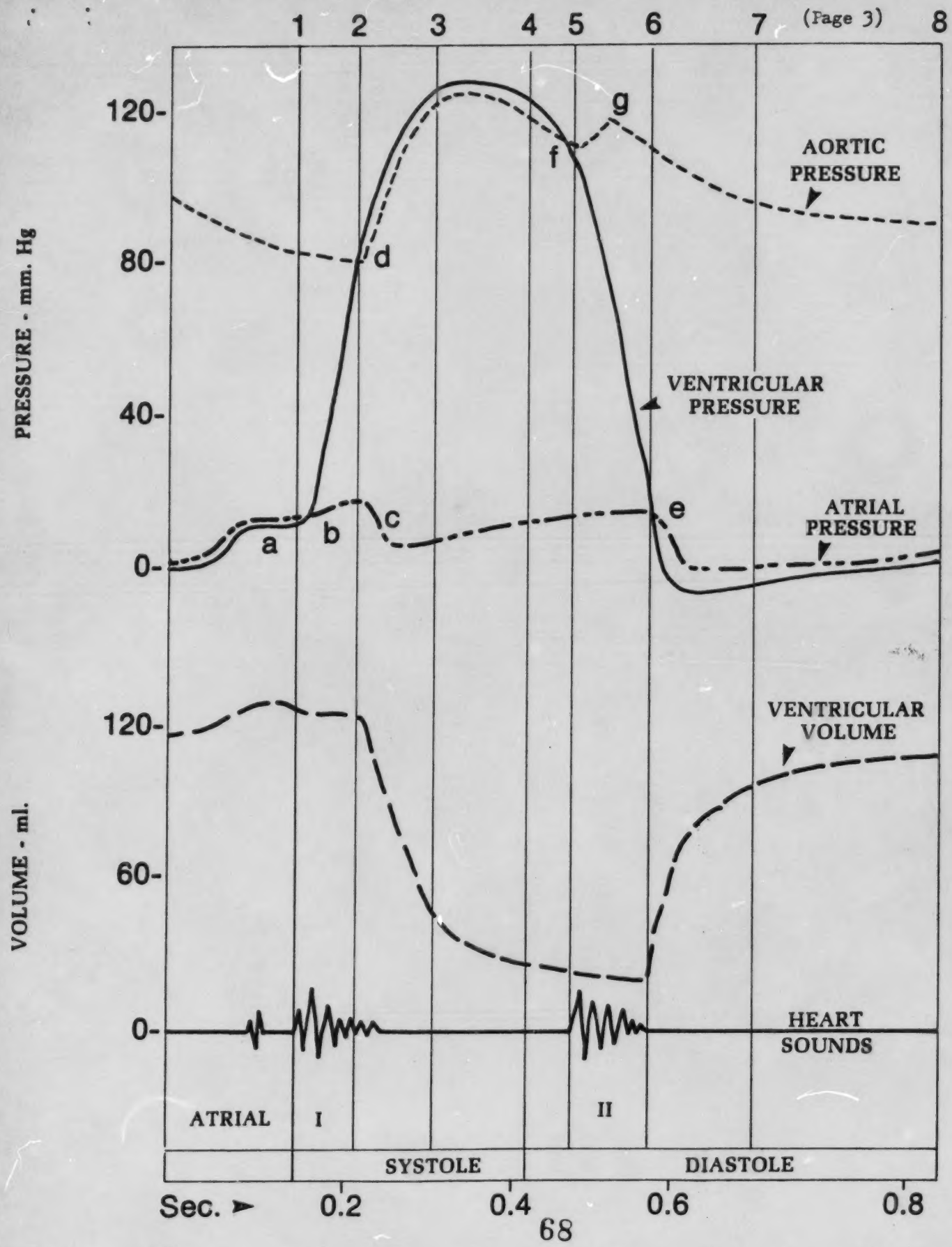
As you already know, contraction and relaxation of heart muscle cause changes in blood pressures within the four chambers of the heart. These changes in blood pressure cause the heart valves to open or close, directing blood to different chambers of the heart and out into the large arteries.

The changes in atrial and ventricular pressures and in ventricular volume during the cardiac cycle are often presented in a graph similar to the one accompanying this unit. You can find this type of graph on page 402 of Tortora* and on page 126 of Guyton** as well as in many other anatomy and physiology textbooks. Most students find these graphs useful for reviewing their knowledge of heart action, since the graph correlates the different changes in blood pressures and volumes and consequent flow of blood with each action of the the heart muscle and heart valves. In addition the graph accompanying this unit correlates the heart sounds with the heart actions.

In order that you may frequently and conveniently consult the large graph on Page 3, reduced copies are repeated on succeeding pages. Most information in the unit as well as in the practice questions and post-test refer specially to this graph. You should also set one of the heart models (available from the instructor) in front of you when you begin. If a heart model is not available, refer to diagrams of the heart, such as the ones on pages 365 and 366 of Tortora and page 125 of Guyton, and the diagrams of the heart in your handout materials.

*Tortora and Anagnostakos, Principles of Anatomy and Physiology (San Francisco: Canfield Press, 1975).

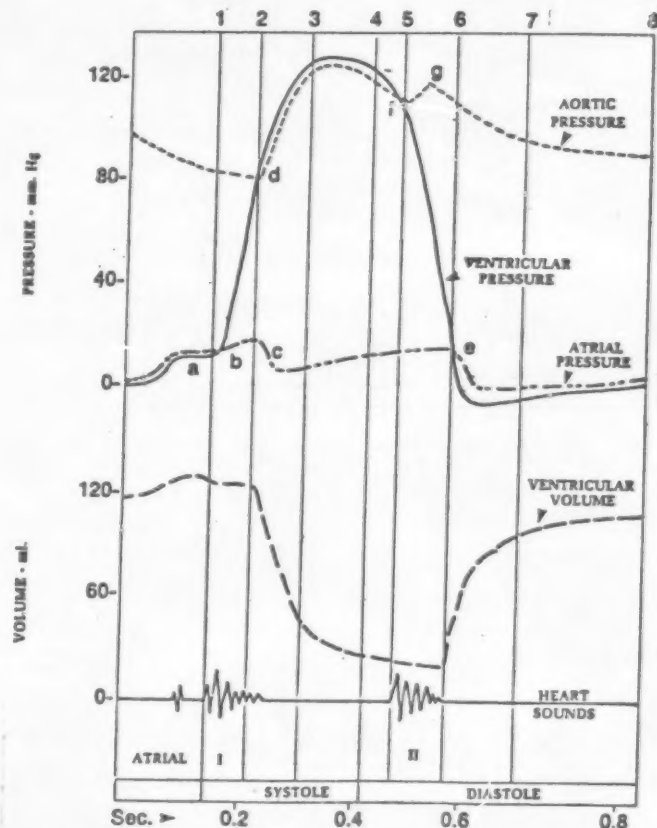
**A. C. Guyton, Basic Human Physiology: Normal Functions and Mechanisms (San Francisco: W. B. Saunders Co., 1971).



Since heart actions occur in a rhythmical cycle, you may study all of the heart actions in order by starting at a point in one cycle and continuing until you reach that same point in the next cycle. You will start your study of this unit at point e (roughly 0.55 second) on the graph, which corresponds to the time the ventricles begin filling with a new supply of blood. You will then study heart events moving to the right on the graph until you reach the 0.8 second mark, then move to the extreme left end of the graph (the 0 second line) and continue your study until you again reach point e. This will take you through one complete filling of the ventricles, their subsequent emptying, then to the point where they begin filling again. Note that the 0.8 second line of one cycle is the same as the 0 second line of the next cycle.

1. At what point in the cardiac cycle do the ventricles begin to fill? (Circle one.)

- a. point a
- b. point d
- c. point e
- d. point f



Answer

Point e denotes the time at which the ventricles begin to fill.

You're ready to start the cycle after this one further note: you will notice that the blood pressures shown are those attained on the left side of the heart, that is, in the left atrium, left ventricle, and the aorta as it leaves the left ventricle. The blood pressure in the right ventricle and pulmonary trunk change at the same time and for the same reasons as on the left side of the heart, but do not reach as high a level.

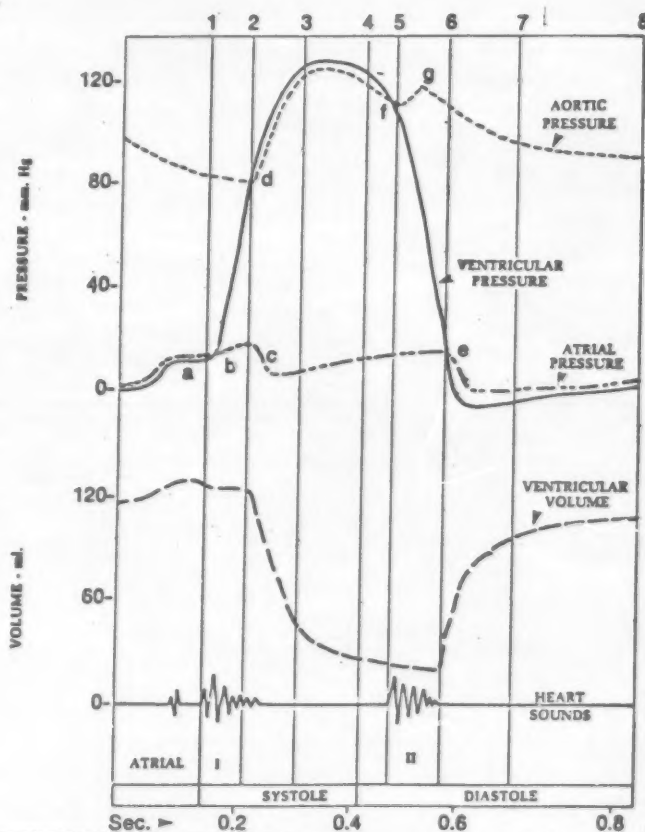
Now consider the conditions in the heart at point e which allow the ventricles to begin filling.

Note that the ventricular blood pressure has been dropping rapidly. This is due to rapid relaxation of the ventricles (ventricular diastole) following ventricular systole.

At point e, the ventricular blood pressure becomes lower than the atrial blood pressure. The blood in the atria consequently tries to flow into the ventricles, forcing the atrioventricular valves open, and accomplishing just that purpose!

2. The ventricles will fill with blood as which of the following conditions exist? (Circle as many as apply.)

- arterial blood pressure is at its peak
- atrial blood pressure is higher than ventricular blood pressure
- atrioventricular valves are open
- semilunar valves are open
- ventricles are in diastole



Answer

Conditions "b", "c", and "e" exist all the time the ventricles are filling.

Did you identify all three? If so, you're relating these different events

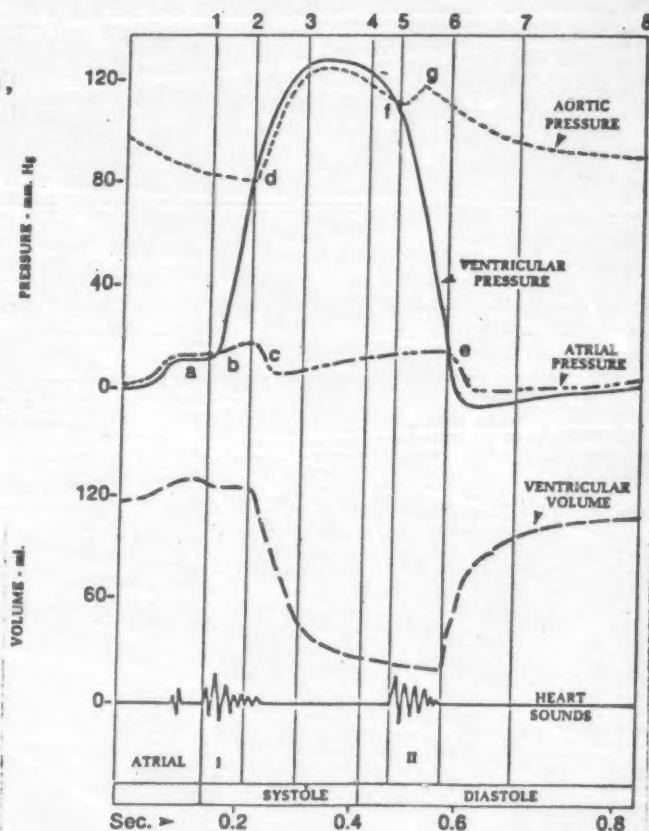
very well! If, on the other hand, you need to go back over this page, consider

the meaning of this scheme: condition e condition b condition c

Initially, the ventricles fill very rapidly, as you can see by the rapid rise in ventricular volume just following point e. This is due to blood pooling ("piling up") in the atria, auricles, and proximal veins during ventricular systole and the first part of ventricular diastole before the atrioventricular valves open. When the atrioventricular valves do open at point e, this large mass of blood gushes into the ventricles, rapidly filling them.

3. Ventricles initially fill rapidly with blood because: (Circle as many as apply.)

- a. blood has accumulated in the atria and proximal veins prior to this time
- b. the atria contract to force blood into the ventricle
- c. the ventricles have just begun to relax.



Answer

You can gush over your expertise if you circled "a". The events talked about in answers "b" and "c" happen at other times, and have no "carryover" effect as does the event in answer "a".

The atrial blood pressure naturally drops as the upper chambers of the heart lose their pooled blood into the ventricles. As this blood gushes into the ventricles, would you expect it to raise or lower the ventricular blood pressure? . . .

Follow the ventricular pressure and volume lines on the graph from point e to 0.6 second. Does the ventricular pressure rise or fall with the rising ventricular volume? . . .

Did you discover the seeming paradox that ventricular pressure drops while the ventricles fill with a large amount of blood? To help explain this paradox, consider what happens to the size (volume) of the ventricles as they relax. Like all other muscles, ventricular walls are able to get longer (to a limit) as they relax, increasing the volume of the ventricles. Between point e and 0.6 second, the volume of the ventricles actually increases more than the volume of blood being taken in. Consequently, the pressure of that blood continues to drop within the ventricles until 0.6 second.

4. Both the atrial blood pressure and the ventricular blood pressure:
(Circle one.)

- a. drop rapidly when the ventricles begin to fill.
- b. rise rapidly when the ventricles begin to fill.

Answer

The graph indicates that "a" is correct.

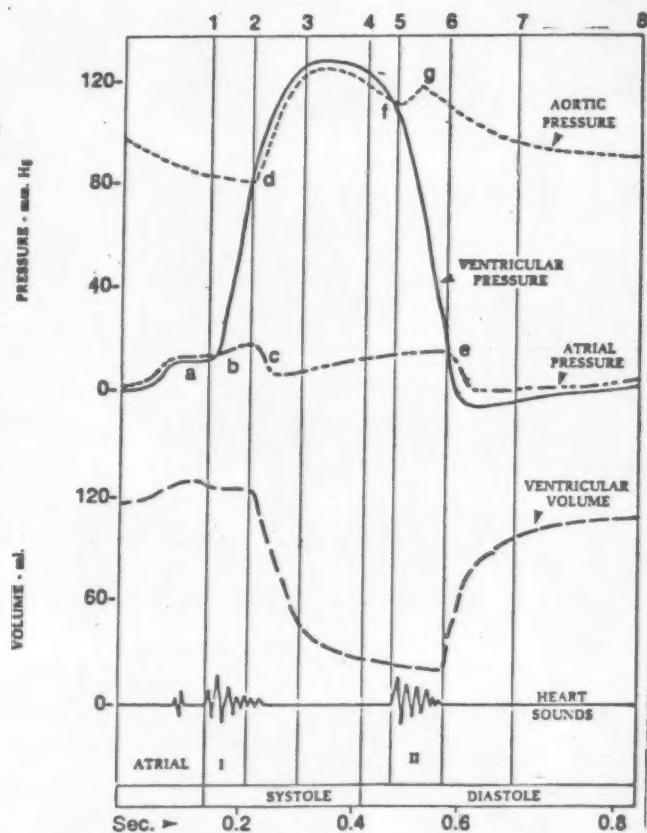
Hope you were able to wade through the explanation for it!

At 0.6 second, the ventricles are at their most relaxed length. After 0.6 second, blood entering the ventricles from the veins (via the atria and atrioventricular valves) must have enough force to stretch the ventricular walls beyond this length. This causes a gradual increase in both atrial and ventricular blood pressure, as you can see on the graph in the period from 0.6 second to 0.1 second (of the next cycle).

At 0.1 second the atrial muscles must contract (atrial systole) to put enough pressure on the blood within the atria to propel it into the ventricles. The resulting small rise in ventricular volume also creates a slightly higher ventricular pressure.

5. Atrial contraction, at about 0.1 second, causes:
(Circle as many as apply)

- a. a small rise in arterial blood pressure
- b. a small rise in atrial blood pressure
- c. a small rise in ventricular blood pressure
- d. a small rise in ventricular blood volume



Answer

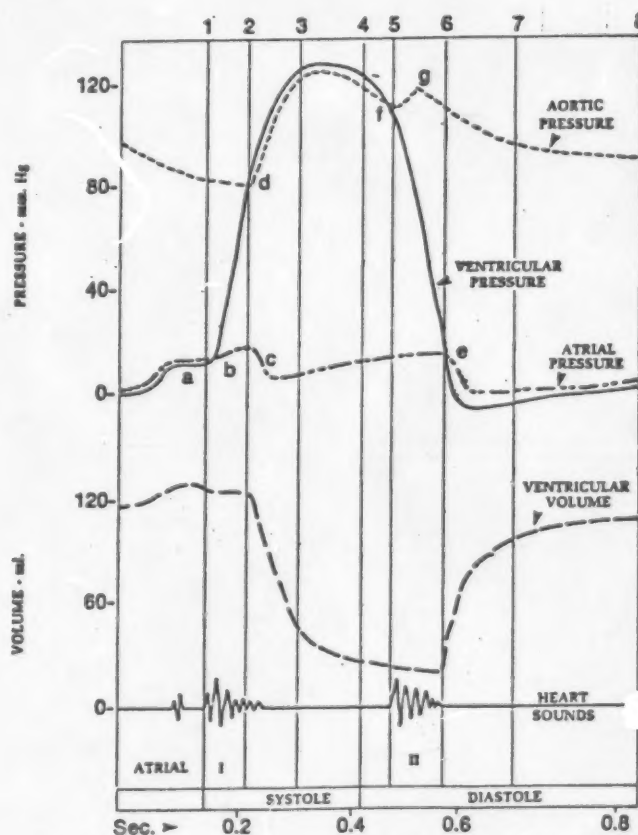
Three cheers for answers b, c, and d! They are all related, whereas the arterial blood pressure (in answer a) is not affected until later.

Atrial systole ends at point a. Immediately, ventricular systole (contraction) begins, causing a rapid rise in ventricular pressure. The blood in the ventricles is forced upwards, both towards the atria and toward the large proximal arteries.

A small rise in ventricular pressure brings it equal to the atrial pressure at point b. This closes the atrioventricular valves so that blood will not back up into the atria. Moreover, the blood that is moving back toward the atria is stopped so abruptly that it sets up a shock wave which can be heard as the first heart sound.

6. The first heart sound, beginning at point b, corresponds to: (Circle as many as apply.)

- a. the closing of the atrioventricular valves.
- b. the closure of the semilunar valves.
- c. the opening of the atrioventricular valves.
- d. the opening of the semilunar valves.



Answer

"Lubb" is due to a.

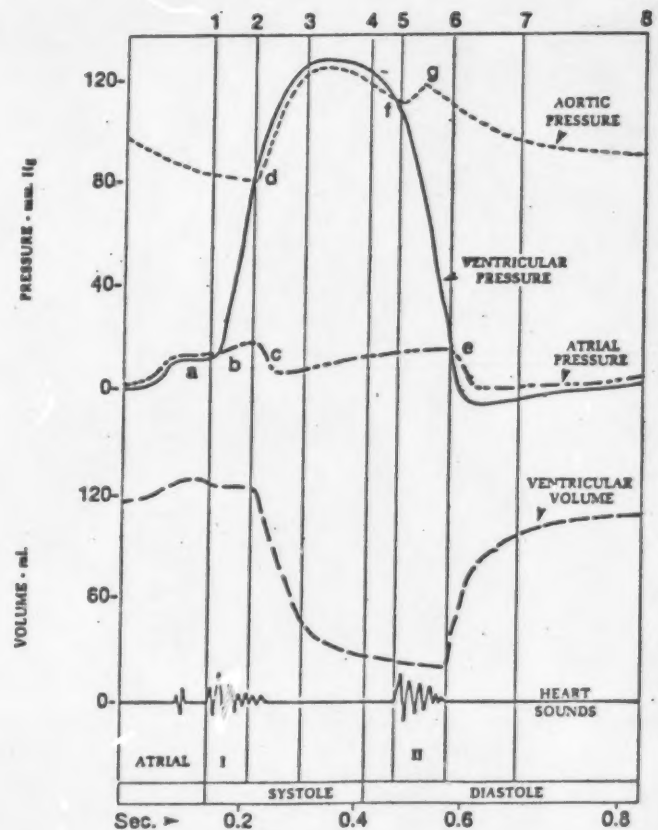
b shakes things up later in the cycle

c and d help move blood, rather than stopping and shaking it.

To open the semilunar valves and eject the ventricular blood out into the arteries, a much higher ventricular pressure is required because of the normally high arterial pressure. Not until point d is reached is the ventricular blood pressure great enough to open the semilunar valves.

7. In the period from point b to point d:
(Circle one.)

- a. the atrioventricular valves are open, the semilunar valves closed.
- b. the semilunar valves are open, the atrioventricular valves closed.
- c. all four heart valves are open.
- d. all four heart valves are closed.



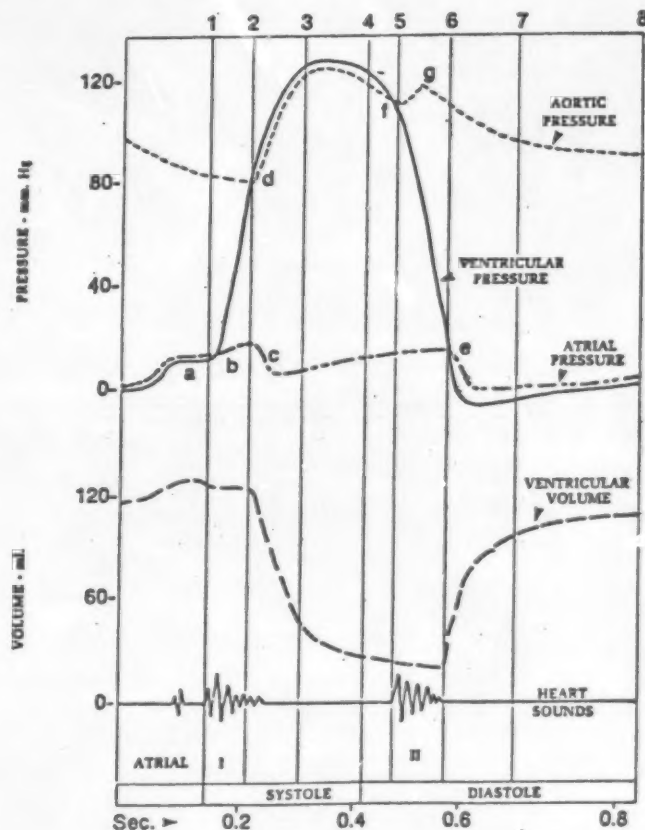
Answer

You're not stuck if you answered "d" (the blood is).

Between point b and point d, the ventricles are contracting while all of the heart valves are closed. The blood can't go anywhere: it must remain in the ventricles to get squeezed harder and harder! The period during which ventricular pressure increases greatly while the blood within the ventricles doesn't move is called isometric contraction.

8. The portion of ventricular systole from point b to point d is termed: (Circle one.)

- a. isometric contraction.
- b. isotonic contraction.
- c. ventricular diastole.
- d. ventricular fibrillation.
- e. none of these.



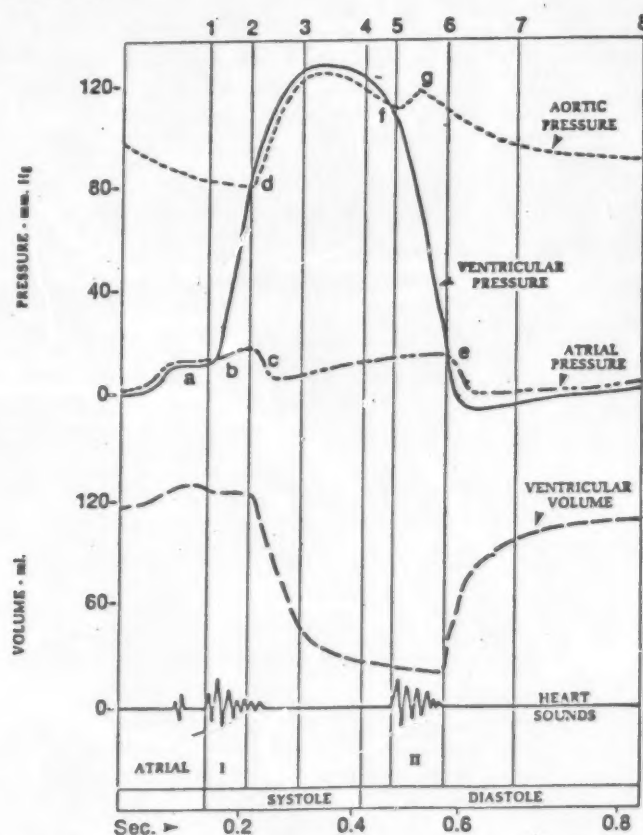
Answer

"a" is the term. Can you relate this meaning of isometric contraction with isometric exercises of the skeletal muscles?

The isometric contraction of the ventricles bears fruit at point d, when the ventricular pressure equals the arterial pressure. The semilunar valves are forced open as ventricular contraction raises the ventricular pressure above the arterial pressures. Pent-up blood rushes out of the ventricles especially rapidly for the ensuing tenth of a second (from 0.2 second to 0.3 second of the new cycle).

9. The contraction of the ventricles is most effective in forcing blood into the arteries: ((Circle one.))

- a. from point a to point b
- b. from point b to point e
- c. from 0.2 second to 0.3 second
- d. from 0.3 second to point f
- e. from point f to point e



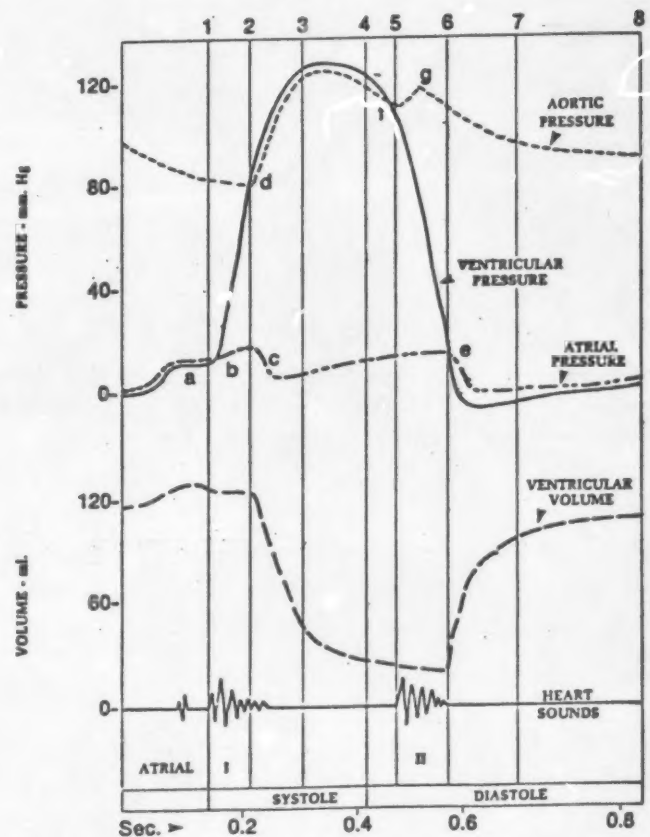
Answer

During time period "c", the blood is really moving! And so are you, if you answered this one correctly.

Even though the biggest portion of the ventricles' blood rushes out into the arteries between 0.2 second and 0.3 second, the ventricles exert an even stronger contraction. This raises both the ventricular and arterial blood pressures to their peak at 0.3 second.

10. When the initial volume of blood is forced into the arteries:
(Circle as many as apply.)

- a. the atrial pressure rises sharply
- b. the arterial pressure rises to a peak
- c. the ventricular pressure rises sharply
- d. the ventricular pressure drops sharply



Answer

"b" and "c" are the sharp answers.

The peak of ventricular pressure cannot be maintained after 0.3 second, however. Notice the small ventricular volume at this point: this is a very reduced amount of blood for the ventricular walls to push against. Consequently, the last tenth of a second of ventricular contraction (from 0.3 second to 0.4 second) is accompanied by a gradual drop in ventricular pressure. The arterial pressure also drops, since it is partly dependent on the force of blood newly ejected from the ventricles.

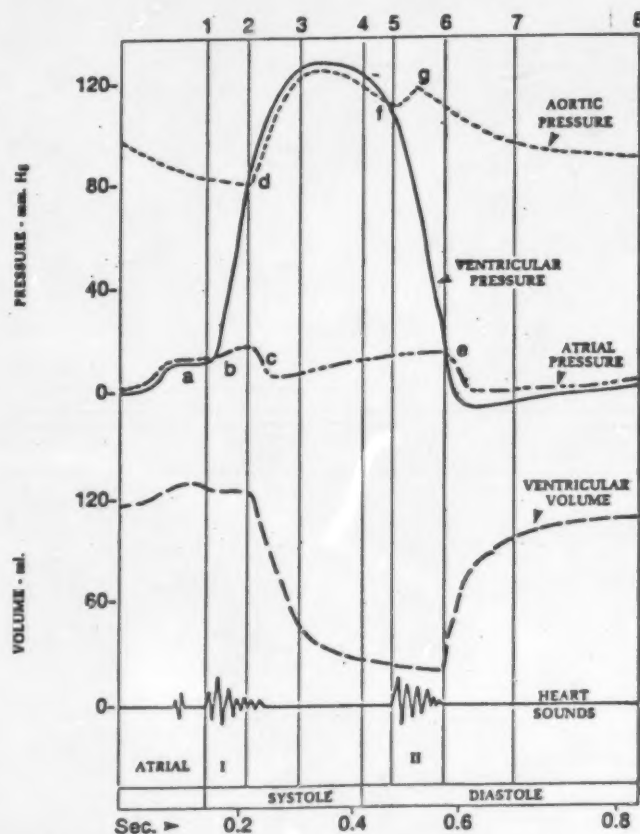
At 0.4 second, the ventricles start to relax. In the first phase of ventricular diastole (from 0.4 second to point f), the ventricular pressure drops slightly. However, it is dropping more than the arterial blood pressure, so that at point f the ventricular pressure equals the arterial pressure, and the semilunar valves again close.

When the semilunar valves close, high-pressure arterial blood attempting to flow back into the ventricles slaps against the valves, setting up a shock wave heard as the second heart sound. The shock wave also causes a small, swift, but temporary rise in arterial pressure from point f to point g, which you see as the "dicrotic notch" on the graph.

After the closing of the semilunar valves at point f, the ventricles relax rapidly, causing the ventricular blood pressure to drop very rapidly. At point e, the ventricular pressure is low enough that the atrioventricular valves again open, the ventricles again begin filling, and another cycle begins from this point.

11. When the semilunar valves close, at point f: (Circle as many as apply.)

- a precipitous drop in ventricular blood pressure begins.
- a small but swift rise in atrial blood pressure occurs, causing the "dicrotic notch" on the graph.
- the second heart sound is produced.



Answer

All these events occur at point f, making it a significant landmark.

This question is a significant landmark, too, because if you feel ready for it, you can now take the post-test.

Post-Test

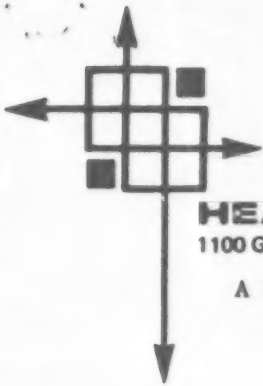
Circle only one answer choice per question.

1. The ventricles begin to fill at approximately what point in the cardiac cycle?
 - a. 0.2 seconds
 - b. 0.4 seconds
 - c. point f
 - d. point e
2. When the ventricles begin to fill, the heart chambers are:
 - a. all in systole.
 - b. all in diastole.
 - c. the atria are in systole, the ventricles in diastole.
 - d. the ventricles are in systole, the atria in diastole.
3. The ventricles begin to fill when:
 - a. the atrioventricular valves open.
 - b. the atrioventricular valves close.
 - c. the semilunar valves open.
 - d. the semilunar valves close.
4. During ventricular filling:
 - a. atrial blood pressure exceeds ventricular blood pressure.
 - b. ventricular blood pressure exceeds atrial blood pressure.
 - c. atrial blood pressure and ventricular blood pressure are equal.
5. The beginning of ventricular filling is accompanied by:
 - a. a rapid fall in atrial pressure.
 - b. a rapid rise in ventricular pressure.
 - c. a rapid fall in ventricular pressure.
 - d. both a and b
 - e. both a and c
6. Filling of the ventricles is most rapid between approximately 0.55 seconds and 0.7 seconds because:
 - a. blood has accumulated in the atria and the proximal veins during ventricular contraction.
 - b. the atria contract at this time.
 - c. the atrioventricular valves close at this time.
 - d. the semilunar valves close at this time.
7. The small rise in atrial blood pressure, ventricular blood pressure, and ventricular volume at approximately 0.1 seconds is due to:
 - a. closing of the atrioventricular valves.
 - b. contraction of the atria.
 - c. contraction of the ventricles.
 - d. opening of the semilunar valves.

8. The sharp rise in ventricular pressure from point a to 0.3 seconds is due to:
 - a. closing of the atrioventricular valves.
 - b. contraction of the atria.
 - c. contraction of the ventricles.
 - d. opening of the semilunar valves.
9. Isometric ventricular contraction occurs:
 - a. from 0.1 second to 0.2 second
 - b. from 0.1 second to 0.3 second
 - c. from point a to point b.
 - d. from point b to point d.
 - e. from point d to point f.
10. During isometric ventricular contraction:
 - a. the atrioventricular valves are open, the semilunar valves closed.
 - b. the semilunar valves are open, the atrioventricular valves closed.
 - c. all four heart valves are open.
 - d. all four heart valves are closed.
11. From point d to point f:
 - a. the atrioventricular valves are open, the semilunar valves closed.
 - b. the semilunar valves are open, the atrioventricular valves closed.
 - c. all four heart valves are open .
 - d. all four heart valves are closed.
12. The rapid rise in arterial blood pressure from 0.2 second to 0.3 second is due to:
 - a. contraction of the atria
 - b. contraction of the ventricles
 - c. the sudden increase in blood volume in the arteries proximal to the heart
 - d. both a and b
 - e. both b and c
13. The small but swift rise in arterial blood pressure from point f to point g (the "dicrotic notch") is due to:
 - a. closure of the atrioventricular valves
 - b. closure of the semilunar valves
 - c. opening of the atrioventricular valves
 - d. opening of the semilunar valves
 - e. both b and c
14. The first heart sound is due to:
 - a. closure of the atrioventricular valves
 - b. closure of the semilunar valves
 - c. opening of the atrioventricular valves
 - d. opening of the semilunar valves
 - e. both b and c
15. The second heart sound is due to:
 - a. closure of the atrioventricular valves
 - b. closure of the semilunar valves
 - c. opening of the atrioventricular valves
 - d. opening of the semilunar valves
 - e. both b and c

Answer Key to Post-Test

1. d
2. b
2. a
4. a
5. e
6. a
7. b
8. c
9. d
10. d
11. b
12. e
13. b
14. a
15. b



HEALTH INSTRUCTION EXCHANGE

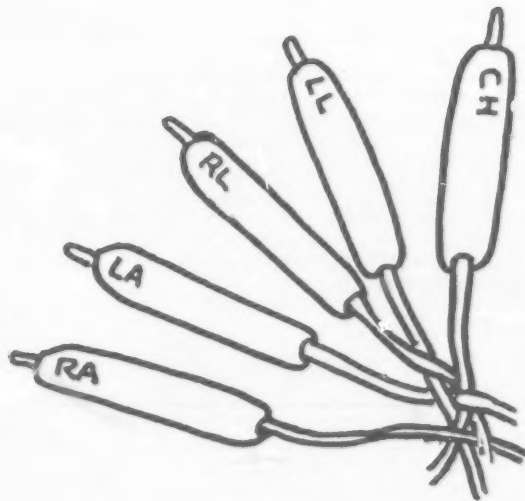
1100 Glendon Avenue □ Westwood Center □ Suite 925 □ Los Angeles, CA 90024 □ 213 478-1411

A PROJECT OF THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE

THE E K G CONNECTION: PATIENT, LEAD WIRES AND ELECTRODES

By

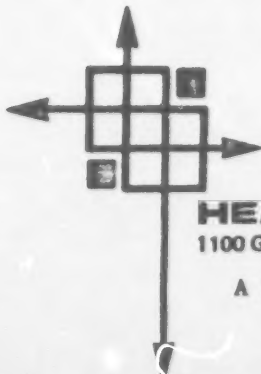
Judy Coleman, CMA-AC



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TITLE OF PACKAGE:	The EKG Connection: Patient, Lead Wires and Electrodes
AUTHOR:	Judy Coleman
INSTITUTION:	El Centro College
INTENDED STUDENTS:	Medical Assisting Nursing Students
ESTIMATED WORKING TIME:	20 to 30 Minutes
MATERIALS NEEDED:	Patient Cable Wires Electrodes, limb and chest
REVISED:	Nov. 1, 1977

NOTE: For effective use
of this unit, the elec-
trodes should already be
attached to the limbs and
chest.



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A PROJECT OF THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE

INTRODUCTION

This package will introduce the student to the patient cable lead wires and their connection to the electrodes. It is part of a module on electrocardiography techniques.

OBJECTIVES OF UNIT

Overall Objective

The student will identify, select, and attach the patient cable lead wires to the electrodes on the four limbs and chest for an electrocardiographic tracing.

Sub-Objectives

1. Identify the five patient cable lead wires.
2. Select the specific patient cable lead wire and the corresponding body area to which it is to be attached.
3. Indicate the correct position for application of limb and first chest electrode.
4. Connect the patient cable lead wires to each limb and chest electrode.

PRACTICE EXERCISE #1

For easy identification the patient cable lead wires are each lettered and color coded.

<u>ELECTRODE LOCATION</u>	<u>ALPHABETICAL CODE</u>	<u>COLOR CODE</u>
RIGHT ARM	RA	WHITE
LEFT ARM	LA	BLACK
RIGHT LEG	RL	GREEN
LEFT LEG	LL	RED
CHEST	CH	BROWN

You will be furnished a patient cable lead wire for practice in this unit. (Ask Instructor)

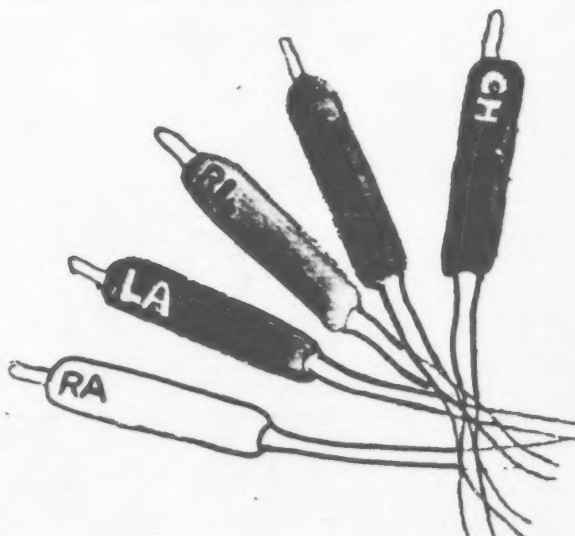
Your task will be to identify each of the patient cable lead wires.

Take the ends of the patient cable lead wires in your hands and examine the ends. Notice they have all different colors! Rotate the ends - note that they have letters - RA - LA - RL - LL - CH on them.

The letters identify the body areas where the cable wires are to be attached.

Read the list below, and using the patient cable wire, identify each wire.

1. RA - white - right arm
2. LA - black - left arm
3. RL - green - right leg
4. LL - red - left leg
5. CH - brown - chest



Now that you have identified the lead wires, you are ready to advance.

1. Cover the top of this sheet and check your self on identification of lead wires by completing the following exercise.

Fill in the blanks:

- 1) The RA - white lead wire is for the _____.
- 2) The LA - black lead wire is for the _____.
- 3) The RL - green lead wire is for the _____.
- 4) The LL - red lead wire is for the _____.
- 5) The CH - brown lead wire is for the _____.

To check your answers, refer to above section. How did you do? If you have the correct answers, proceed to the next section. If you have any incorrect answers, repeat this page.

PRACTICE #2

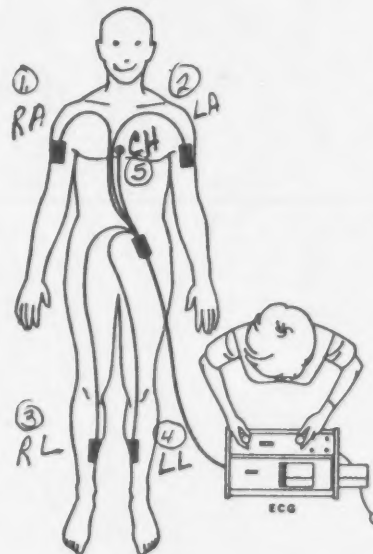
In order to have an electrocardiographic recording that is true, the correct lead wire must be attached to the corresponding limb electrode and the chest lead wire to the chest electrode. Incorrect attachment will produce a false graph and cause a wrong diagnosis.

Practice Question #2

Select a lead wire and the body area to which it is to be attached.

From the drawing, identify the five body areas to which lead wires are attached.

- #1 _____
- #2 _____
- #3 _____
- #4 _____
- #5 _____



PRACTICE EXERCISE #2 (Cont.)

Given the 5 body areas - select the lead wire that is to be attached to that area. Write in your answer below.

<u>Body areas</u>	<u>Code letter</u>	<u>Color code</u>
1) Right arm	_____	_____
2) Left arm	_____	_____
3) Right leg	_____	_____
4) Left leg	_____	_____
5) Chest	_____	_____

Check your answers:

<u>ELECTRODE LOCATION</u>	<u>ALPHABETICAL CODE</u>	<u>COLOR CODE</u>
RIGHT ARM	RA	WHITE
LEFT ARM	LA	BLACK
RIGHT LEG	RL	GREEN
LEFT LEG	LL	RED
CHEST	CH	BROWN

If you are correct, you have met your objective and should advance to the next practice exercise.

If you have any incorrect answers, please repeat this section.

PRACTICE EXERCISE #3

The position for attachment of the limb electrodes is the upper outer fleshy portion of the arms and the inner-medial fleshy portion of the calf of the legs. The first chest electrode is attached to the chest at the fourth inter-costal space just to the right of the sternum.

Review diagram A. Note position of limb and chest electrodes.

Review diagram B. Note position of chest electrode 1.

(See Next Page)

Practice Question #3

- 3A. On the diagram C mark with an "X" the position where the limb and chest electrodes should be attached.

Check your answers by diagram D. (Page 9)

Please proceed to the next question if you are correct. If not, review this page.

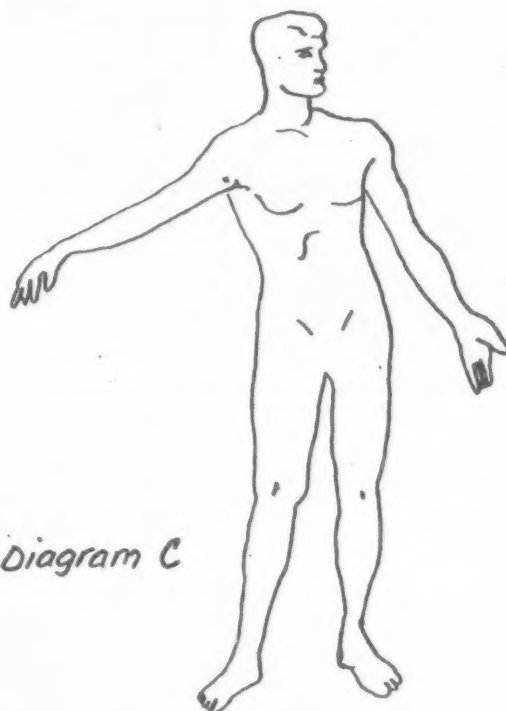


Diagram C

PRACTICE EXERCISE #3 (cont.)

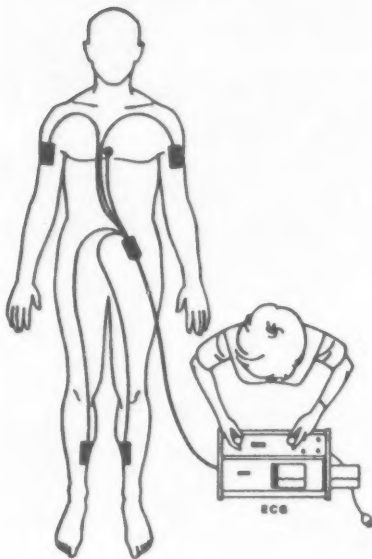
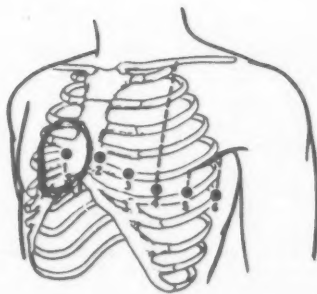


Diagram A

Limb Leads

arms - upper outer fleshy
portion

legs - inner medial fleshy
portion



RECOMMENDED POSITIONS FOR
MULTIPLE CHEST LEADS

Diagram B

Chest Leads

1st Lead - Chest at the 4th
intercostal space just to the
right of the sternum.

PRACTICE EXERCISE #3 (cont.)

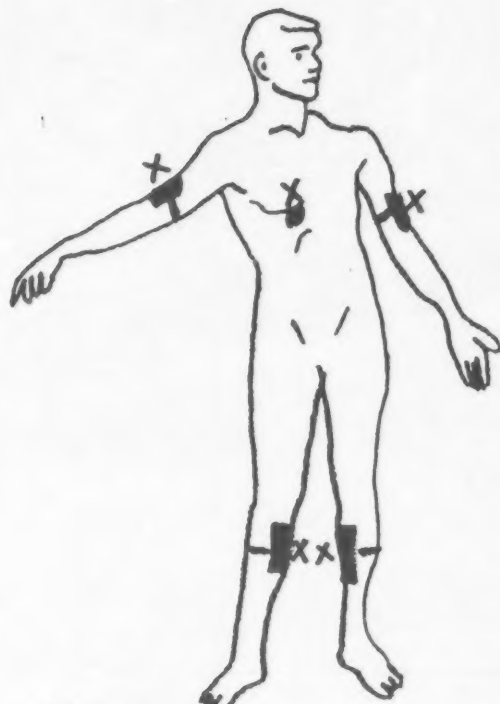


Diagram D

Limb Lead Wires:

arms - upper-outer fleshy portion

legs - inner-medial fleshy portion

Chest Lead Wires:

1st Chest Lead - V^1 -

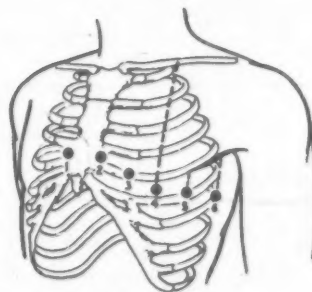
on chest at the 4th intercostal
space just to the right of the
sternum.

PRACTICE EXERCISE #3 (cont.)

3B. Describe on plain sheet of paper, the positions where the limb electrodes and the first chest electrode should be attached.



LIMB ELECTRODE LOCATION



chest positions)

Your answers should be:

- 1) Limb electrodes arms - upper - outer fleshy portion.
- 2) Limb electrodes legs - inner medial fleshy portion.
- 3) First chest electrode - chest 4th intercostal space just to right of sternum.

You are correct, please proceed to the next practice exercise.

Missed one? Please review and test again.

PRACTICE EXERCISE #4

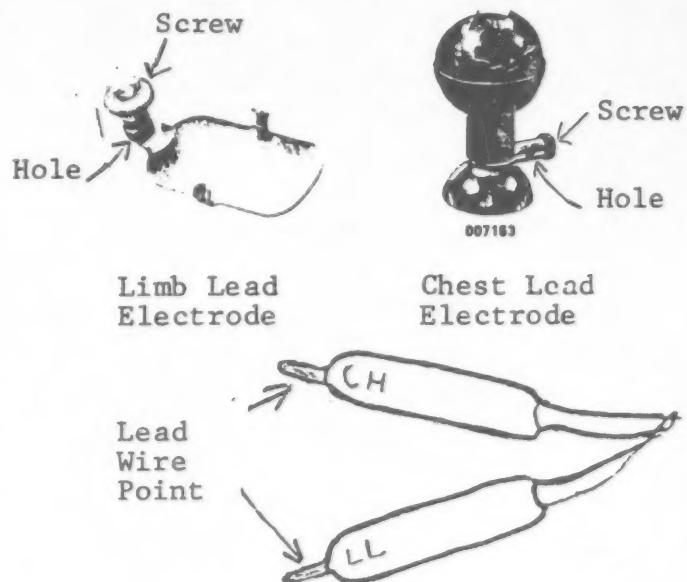
Review previous Module for information concerning the application of electrodes to the patient. Electrodes are already attached to the patient for this exercise.

With the limb electrodes in place, we are now ready to connect the patient cable lead wires to the electrodes. Identify your lead wires and place the point of the lead wire through the hole in the top mid-section of the electrode and then turn the screw on the top of the electrode post until it is tight. This is repeated on all limb lead wires and electrodes.

Identify your chest electrode and place the point of the tip through the hole on the side of the electrode, then turn the screw on the side until the post is tight.

See the instructor to check your performance.

If you are successful, take your post-test.



POST-TEST

1. Identify the patient cable lead wires by matching the following:

_____ 1) LA - black	a. right leg
_____ 2) CH - brown	b. right arm
_____ 3) RA - white	c. left leg
_____ 4) RL - green	d. left arm
_____ 5) LL - red	e. chest

2. Select the patient cable lead wires and the area to which they are to be attached by filling in the blanks with the code letters and the color code.

Limb	Code Letter	Code Color
1) Right Leg	_____	_____
2) Left Leg	_____	_____
3) Right Arm	_____	_____
4) Left Arm	_____	_____
5) Chest	_____	_____

3. On diagram "A" indicate where you would position and place the patient limb electrodes and first chest electrode by marking with an "X."
4. Demonstrate the connection of the end post of the patient cable lead wires to the 1 limb and to the chest electrode. Call the instructor to check your performance. Materials on table.

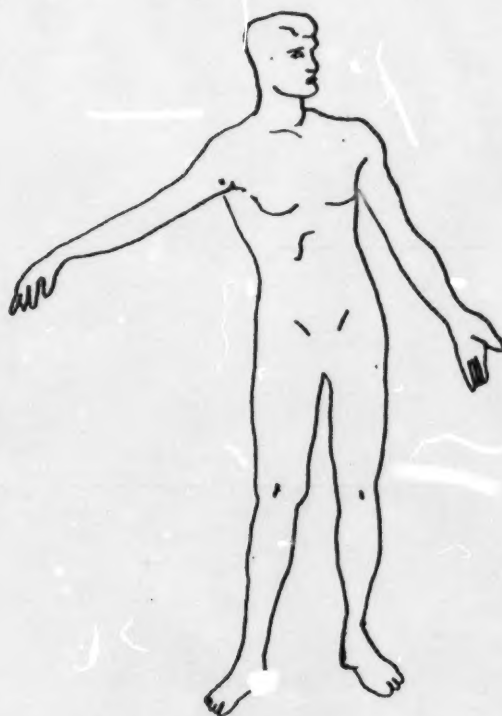
(continued....)

POST-TEST (cont.)

Post Test

Diagram A

Question 3



POST TEST KEY

1.

1. d
2. e
3. b
4. a
5. c

2.

- | | |
|-------|-------|
| 1. RL | green |
| 2. LL | red |
| 3. RA | white |
| 4. LA | black |
| 5. CH | brown |

3.



4. Did you

1. Identify the wire and electrode

A. Limb?

B. Chest?

2. Identify the proper cable lead wire for the specific limb and the chest?

3. Connect the lead wire with the electrode securely?

Instructors Evaluation

Yes _____ No _____